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New Zealand Agricultural & Resource Economics Society

2002 President's Report to the AGM

With support from its growing membership the society is firmly established by now in fulfilling its objectives as set down in the NZARES constitution. Nevertheless, we live a dynamic world and new challenges and tasks will continue to enchant the society's office-bearers. One such task that this committee was charged with was to investigate the possibility of setting up a NZARES web site. To assess the importance a web presence, one need to ask how much time s/he spend browsing the internet on an average day! Earlier this year we launched a temporary web site on a Massey University server (http://econ.massey.ac.nz/nzares/). Limited documents including the 2002 conference programme have been uploaded to this site. Members should view the site and send their comments on its design, and suggest suitable contents. Arrangements have been made for a permanent domain name registration (NZARES.ORG.NZ) and web hosting at reasonable cost, and I will ask members to support this move. The incoming committee may consider appointing a web manager for keeping the site up-to-date.

NZARES remains committed to promote academic and applied research. The society earns its reputation by riding on the research accomplishments of its established researchers while recognising the need to attract fresh talent from the younger generation. To this later end, the society proudly maintains a tradition of giving three postgraduate awards every year. Staring this year, the society reaffirmed its commitment by raising the financial value of the award by 50% to $750 per award. We believe the $10 increase in conference fees is a small price to pay for such worthy initiatives. At least seven student papers are being presented at this year's conference.

The three winners of the 2002 NZARES Postgraduate Award are Sandra Barns from Waikato University, Natasha Longworth from Massey University, and Stephanie Lamotte from Lincoln University. The executive committee solicited nominations from over a dozen department heads/ supervisors in selecting award recipients. The committee wishes to thank all those supervisors that were instrumental in supporting high calibre candidates. As for the award recipients- congratulations!

The 2002 AARES conference was held in February in Canberra. This year saw a repeat performance from Rod Forbes standing as the New Zealand councillor before the conference. Being an affiliate of the AARES, the NZARES committee also administers an award in undergraduate student category. For the 2002 AARES Undergraduate award, we nominated Mark Stevenson from Lincoln University. The award was announced at the AARES conference. The next AARES conference will be held in Freemantle in February 2003. May I remind you that by becoming a member of the AARES, one automatically becomes a member of the NZARES?

Organising the annual conference remains the most challenging and satisfying task for the NZARES committee. You will have noticed the tight scheduling in contributed paper sessions of this conference. This is because we received an overwhelming number of papers. In the end, the committee is pleased in being able to accommodate all presenters (36 papers) that submitted abstracts in time. Keeping up with the trend at many international conferences, this year the committee decided to provide data show projectors in all of the three presentation venues. Presenters now have the choice of making PowerPoint presentations. In terms of participation, in excess of 68 delegates are attending the 2002 conference.

In concluding, I would like to extend my thanks to the outgoing committee members, Jeremy Neild (Secretary), Sue Cassells (Treasurer), Caroline Saunders (President-elect), Irene Parminter and Brian Speirs. Thanks are also due on Rod Forbes for attending the February AARES council meetings in Canberra. My personal gratitude to Irene Parminter for her assistance and advise during my 12-month tenure. Finally, I would like to extend my best wishes to Caroline and her new committee for a successful upcoming year.

Shamim Shakur

Dr Shamim Shakur
President

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The Uruguay Round

Its Significance for New Zealand's Merchandise Exports

With an Emphasis on the Analysis of Tariff Reductions

A report prepared by the Trade and Economic Analysis Division of the Ministry of Foreign Affairs and Trade, Wellington, New Zealand.

March 2002

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1 Key Findings

- **Duties on $17.06 billion of New Zealand exports to WTO founding members were NZ$525 million lower in 2000 than they would otherwise have been[i]. However, these exports continue to attract tariffs (ie taxes) of $884 million so there remains considerable scope to press for further reductions in access barriers applied to our exports.**

- In late 1993, the Uruguay Round (UR) negotiations of the General Agreement on Tariffs and Trade (GATT) concluded. The benefits to New Zealand were expected to include enhanced access at lower tariff levels for our exports, higher world commodity prices as both domestic and export subsidy levels were reduced, and operationally effective trade rules covering aspects such as dispute settlement and sanitary and phytosanitary (SPS) measures.

- This paper evaluates the 'gains' to New Zealand by comparing the tariffs actually paid on our exports in calendar year 2000 to the duties that would have been payable at pre-UR rates. It is therefore a partial one-year snapshot of a single component of UR gains to New Zealand.

- Only those countries that were founding members of the WTO have been considered in the analysis. The sub-set of "duty free" destinations that comprise Australia (CER), Singapore and Hong Kong and economies which have subsequently joined the WTO are excluded.

- **These gains comprise $397 million for agricultural exports exports** (classifications used in this report are as defined by the WTO)[ii]. Agricultural gains are concentrated in the meat and dairy sectors, at $191 and $131 million respectively. Duties of at least $751 million continue to be applied to New Zealand's agricultural exports (an average rate of 7.2 percent).

- Access to the tariff-quota American beef and EU sheepmeat markets remain crucial to New Zealand. The UR delivered an estimated $90 million in duties saved in the EU, our largest meat market during 2000. This was largely the result of enhanced access at zero tariff rates for sheepmeat. Similarly, the US beef market delivered gains of $75 million as a permanent tariff-quota regime at zero tariff rates was negotiated.

- Likewise, continued access for butter to the EU market is crucial. However, the special case represented by the increase in duties on butter exports to the EU that resulted from enhanced and secured access for a larger volume has not been factored into these calculations.

- Large dairy gains were recorded in the ASEAN markets of the Philippines ($38 million over a range of products) and Indonesia ($30 million mostly from whole milk powders). Ten other markets recorded gains of over one million dollars. Nearly half of the remaining dairy duties are concentrated in the EU and the US, our two largest export markets for dairy products. The global dairy market remains highly distorted, with significant tariff and non-tariff barriers restricting New Zealand's exports.

- Other notable gains were recorded from apples and kiwifruit exports into the EU, hides into Korea and processed foodstuffs into Japan.

- **Gains of $128 million were achieved on exports of non-agricultural products (industrial goods, fisheries and forestry). These products continue to attract tariffs of $133 million (an average rate of 2%).** The UR in effect halved non-agricultural tariffs into the founding WTO markets. Nearly one third of these gains were in the Japanese market, followed by Thailand, Korea and the EU. Non-tariff barriers such as standards and building regulations remain as major constraints especially for exports of further-processed forestry products.

- Tariff data, in particular pre-UR data, has proved elusive for a few export destinations. Therefore, the totals given can be expected to under-estimate the true totals.

2 Introduction and Methodology

In late 1993, the Uruguay Round (UR) negotiations of the General Agreement on Tariffs and Trade (GATT) concluded. In April 1994, the Ministry of Foreign Affairs and Trade (MFAT) published an assessment of the likely economic gains resulting from these negotiations.[iii] The objective of this paper is to calculate the gains to New Zealand from enhanced access and tariff reductions arising from trade liberalisation in our overseas markets since the conclusion of the Uruguay Round (UR).

Several different approaches can be used to assess the components of economic benefits of the UR. This report examines the December 2000 year trade data against the market access concessions negotiated during the UR to see where economic gains to New Zealand have occurred. These gains could result from reduced tariffs or from increased quota access. Calculations of the gains to New Zealand from reduced tariffs on the trade for the December 2000 year are made, and the resultant data is presented as gains in the form of reduced tariffs. A similar exercise has been undertaken for some trade items under tariff quota regime, and, where possible, the gains from any extra access calculated. Analysis is conducted in two parts; the agricultural and the non-agricultural sectors. The WTO definitions for agriculture have been used.

A second approach would be to assess the degree to which international commodity prices have risen in light of Uruguay Round outcomes. This could be expected to have occurred through several different channels: the impacts of overall market access gains, the effects of domestic supply reduction in some major (subsidised) markets, and the effects of export subsidy reductions.

A third approach would be to examine the less-obvious but equally important outcomes of the UR, including the benefits resulting from more operationally effective trade rules. Examples include the benefits of secured access for commodity exports into quota markets where access conditions had been deteriorating or were unpredictable, with dairy and sheepmeat access to Europe and beef access into the US areas of key interest to New Zealand. Importantly, the UR negotiations on agriculture focused on the linkages between domestic and international policies which, even if not underpinned by specific commitments, is driving the direction of reform in many countries including the EU, US and others. It also brought agriculture firmly onto the global trade agenda and provided a framework for the continuation of reforms in the sector during the current Doha Development Round. These components are not analysed in this report.

There are three GATT (WTO) categories used in this analysis:

* "GATT members" who were signatories to the UR Agreement (referred to as "GATT" destinations),

* "tariff-free" destinations, a sub-set of those members whose signatures did little to enhance New Zealand's trade access (Singapore and Hong Kong with zero tariffs and Australia, where New Zealand already has free access), and

* "non-members", those trading partners who were not GATT members at the time - although some have subsequently become members of the WTO (eg China; Taiwan).

This analysis is therefore partial and static. The results should be seen as preliminary and indicative. It does not, for example, include the full benefits of gains from better access into tariff quota markets, although some of these gains are considered in the paper.

It is partial in that the gains are defined only as the reduction in the applied tariff for exports during the December 2000 year[iv] compared to what these exports would have paid pre-UR. Gains prior to that time would be smaller, as exports were less and the tariffs were, in many cases, still reducing. Annual gains in the future are likely to increase as the value of exports increases. Only those countries which were founding members of the WTO and which therefore took part in the UR negotiations are included in this study. Australia, Singapore and Hong Kong have been excluded as they are tariff-free markets for New Zealand exports.

Every effort has been made to verify the tariff rates used in this paper, but in some instances it has been difficult to verify the pre-UR rates. Where either a specific or an *ad valorem* duty apply, the *ad valorem* rate has been used. Where there is just a specific duty (or a composite *ad valorem* and a specific rate), the specific rates have been converted using the FoB export values from New Zealand and the importing country currency values of those exports.

Note: All dollar values used in this report are NZ$.

tariff quota for modest volumes of cheese and a small range of other products from frozen cream to butter and competes for global tariff quotas in other dairy products.

In Canada, the tariff quotas of interest to New Zealand are dairy and beef, with beef exports (where New Zealand had a 30.3% Canadian import market share in 1999) currently above the New Zealand country tariff quota and at zero duty. New Zealand has a 75.0 percent market share in the small access opportunities for milk powder and 3.7 percent in cheeses. Over the implementation period, the duties are reducing but the tariff quota allocation is static. A large percentage of New Zealand's agricultural exports to Canada are subject to tariff quota management.

The Philippines has tariff quotas on live animals and meat of interest to New Zealand. Trade in these exports is at low levels.

South African tariff quotas are complex and cover a wide range of items of interest to New Zealand. Trade is limited in these products.

Venezuela has tariff quotas on dairy produce. New Zealand has a major market in milk powders.

Mexico has tariff quotas on dairy imports. The cheese tariff quota system is complex and faces a 20% duty. New Zealand had an 18 percent market share in cheese during 1999. Milk powders enter duty free.

Norway has tariff quotas on beef, sheepmeat and frozen peas. Trade is minimal, although New Zealand had an 61.3 percent market share in sheepmeat and a 21 percent market share in frozen beef during 1999.

Switzerland has a complex tariff quota system covering meat and dairy products as well as cut flowers, apples and wine. The in-quota tariff rates are often high on some items such as butter and beef, with prohibitive out-of-tariff-quota rates. New Zealand was the principal supplier of sheepmeat in 1999, with a 45.4 percent market share, and a 16.9 percent market share in "other meats" (venison).

4.2 Sectoral Analysis

4.2.1 The Dairy Sector (HS 0401 to 0406 inclusive, 2105 and 3501 & 2)

Although a small producer of milk and milk products internationally, New Zealand is a major player in dairy trade. Much of the world's milk is produced in countries such as India where the focus is on domestic supply. The EU is the main international trader, with around 30 percent of global production. New Zealand's production is about 10 percent of the EU's, or nearly 3 percent of the global production[vi]. This production share increased steadily through the 1990s: 1.7 percent in 1993; 1.9 percent in 1994, 1995 and 1996; and then 2.2 percent in 1997 and 1998 according to UN data.

The same UN data shows that at the mid-point of 1996 New Zealand had a 40 percent share of the world trade in butter and casein, 25 percent in whole milk powders (WMP), 16 percent in cheese and 14 percent in skimmed milk powders.

The Organisation for Economic Cooperation and Development (OECD) data[vii] shows that the average export share over the 1995-99 period for New Zealand was 42.6 percent for butter, 20.2 percent for cheese, 19.96 percent for skim milk powder (SMP) and 33.9 percent for WMP. Apart from cheese which remains static, their projections are for this to have increased by 2001: 48.3 percent for butter, 27.97 percent for SMP and 44.42 percent for WMP. Since the OECD expects the EU-15 share of world trade to continue to fall post-2001 as export subsidy commitments take effect, New Zealand's market share can be expected to rise further.

4.2.1.1 Exports by Sector

Between 1993 and 2000, exports of dairy produce increased from $2.78 billion to $4.62 billion, an increase of 66 percent in nominal terms. Seventy one percent went to the main group of GATT members, and trade increased by 52 percent over the period. Another 8.3 percent went to the sub-set of tariff free destinations, and trade increased by a large 218 percent. The final 20.6 percent went to non-GATT members, and trade increased by 73 percent. The following analysis will concentrate upon the GATT members.

By value the main exports are **milk powders** (HS 0402). Powders represented 46.3 percent of total dairy exports over the period. That percentage decreased over the period (49.7 percent in 1993 to 47.9 percent in 2000). It is noteworthy that there were 20 destinations each taking over 1 percent of milk powder exports in 2001. Malaysia is the largest market, with Viet Nam and El Salvador showing the fastest increases of the main markets.

By 2000, **caseins** had become a billion dollar a year export commodity. Just over half of this is US-bound, with another 16 percent destined for the EU. The next most important dairy products were butter (including butter oil) and cheese. For **butter**, the EU was the dominant market by value (30 percent), although exports declined by value over the period. The switch in trade between Russia and Latvia from 1999 is evident in the non-GATT member destinations. The large percentage growth in the US market reflects the fact that product was traded above the in-tariff quota volumes from 1998. The **cheese** trade doubled over the period under examination, and increased market share of total New Zealand dairy exports from 18.3 percent in 1993 to 23.6 percent in 2000. By value the US displayed the largest increase, although the Korean market grew by a large percentage from a small base. Finally, there are three other milk products of **fresh milk, buttermilk and whey products**, each with exports below $100 million.

4.2.1.2 Exports By Market

The EU15

The EU, with a 14.46 percent share of New Zealand's dairy exports in 2000, is the most important and also the most complex market to assess. It is the most important because it is the largest market while, at the same time, it is also the main competitor. It is the most complex because several different factors need to be taken into account. The first is that during the UR negotiations a formula was agreed for larger access volume with a higher tariff rate. The second is the gains in international prices which came about from both the UR mandated reductions in export subsidies[viii] and the unilateral liberalisation from both the reforms of the MacSharry plan and Agenda 2000. While unilateral, they occurred against the background of the UR. The simultaneous nature of these reforms and the UR means that it is difficult to separate the relative influences of one against the other.

The EU dairy market remains highly protected. Even after the UR implementation period, the mean unweighted tariff on dairy imports into the EU is 87 percent. The average in-quota average tariff on dairy products is still 30 percent.[ix] Domestic production is controlled by quota. Exports are made possible by export subsidies, although the UR constraints are starting to impact on dairy exports. The domestic support levels remain high, although a useful start to liberalise was made in the 1992 MacSharry reforms. The basic price structure remained in place but prices were reduced to nearer world levels and "compensatory" or direct payments were introduced. These reforms were extended in Agenda 2000, although the practical effect was limited as production quotas remain.

The big change as a result of the UR was the permanent country-specific access of 76,667 tonnes of butter at a levy of 868.8 ECU[x] per tonne. This was set against the background of the (likely declining) access of 51,830 tonnes at a levy of 408.6 ECU per tonne. The extra access gained increased **gross** revenue of some $97 million in 2000, but to gain this an extra $45.4 million in tariffs was paid. Thus, the 24,837 tonnes yielded a post-tariff **nett** revenue of $51.7 million for an average price of $2,080 per tonne. The average value of the extra quantity into the EU was lower than the "world minus the EU" average export value of $2,947 per tonne. A difficulty occurs in assessing the value of marginal sales on the world market, and, more importantly, what the marginal value would have been in the absence of the extra 24,837 tonnes (11 percent of total exports) exported to the EU. In a period of high world prices the marginal value on the world market is likely to be higher, but such is the market share of New Zealand exports to the world that the extra tonnage exported to Europe will, in fact, influence that world price. In the final analysis, butter exports in 2000 were 3 percent by value below the 1993/94 base used in this report. This needs to be viewed against an overall increase in the value of butter exports from New Zealand to the world of 39 percent.

For cheese, there was an increase in global quota access in the EU from 34,000 to 102,150 tonnes. New Zealand exported a total of 246,000 tonnes of cheese in 2000; thus, the increased EU global access represented a volume equivalent to some

28 percent of New Zealand's total exports. In addition, New Zealand has a static country-specific quota of 11,000 tonnes of processed and cheddar cheese into the EU: 16.7 percent of cheese exports in 2000 by value went to the EU, up only marginally from 15.1 percent in 1993. By value there was an increase of 54 percent to the EU in 2000 over the 1993/94 average base, and this figure was below the increase of 100 percent (ie., doubling) to the world over the same period. For the 2000 year, the value dropped below the figures for the previous three years to be just above the 1996 value. Thus, other than the "second round" impacts of other exporters sending cheese to the EU rather than third markets, it is difficult to say more than that the 2000 value of $133 million was an increase of 54 percent or $46.8 million. There were no duty savings from the cheese trade.

For powders, the EU increased its global tariff quota from 40,400 tonnes to 68,000 tonnes by 2000. Exports to the EU of New Zealand milk powders are very small - around one-third of a percent of total exports in 2000 and down by 68 percent against the base 93/94 period. Duties reduced from 116 to 75 percent for whole milk powder, and this, along with reductions from 39 to 25 percent for skim milk powder, resulting in gains to powder exports of $4.4 million.

Modest gains were made in tariff reductions in the casein and caseinate trade (HS 35). For the main category of caseins tariffs were reduced from 10 to 6.4 percent, while the remaining exports went from 2 percent to free. Overall, based on the 2000 exports, this amounted to a gain of $4.8 million in the form of reduced tariffs. There were no duties on albumins.

Remaining duties of $176.5 million on dairy exports to the EU of $695 million (25.4% average duty) are the largest single market/sector amount of duties faced by New Zealand exporters.

Malaysia

The next largest traditional dairy market in 2000 was **Malaysia** with 6.78 percent of exports. Access into Malaysia was not affected by the UR outcome, and applied rates are generally below the bound rates. Remaining duties were only $1 million, $4.4 million lower than before the UR. Most of this saving resulted from the applied rate on powders reducing from 1.3 percent to zero, below the bound rates of between 1.8 and 5.0 percent.

The US

The US, like the EU, Canada and Japan, remains a controlled market for much of New Zealand's dairy produce. New Zealand did gain country-specific access for cheddar cheese at a marginally reduced tariff rate. Cheese exports increased by 158 percent over the period, and in 2000 the US took some 15 percent of New Zealand's total exports of cheese. As with the EU, the reducing limits on export subsidies for dairy products were most likely a factor in the increasing world prices in recent years. Total dairy exports to the US were $839.6 million, and the remaining duties were $46.9 million. Savings were $8.1 million, with $3.26 million of this from cheese

exports and almost all the remainder from casein. The problem of prohibitive out-of-quota-tariff rates remains.

Japan

The result of the UR was to "hold the line" on dairy exports. The 11,550 tonne prepared edible fats trade was maintained, and access for the then current levels of butter cheese and powder exports was secured. The applied duties were $1.6 million lower in 2000 than the pre-UR base rates. Remaining duties are $8.8 million on exports of $441.7 million. The problem of prohibitive out-of-quota-tariff rates remains.

Canada

New Zealand has a country-specific butter quota, rising from 1,200 tonnes to 2,000 tonnes over the implementation period, and access to Canada's global quota. Other gains were the $5.6 million in reduced duties in 2000. Remaining duties are only $2.3 million on trade of $92 million, reinforcing the fact that both access and out-of-tariff quotas are the problem.

Mexico

Mexico eliminated all quantitative restrictions, including import licensing and domestic mixing regulations. Exports to Mexico have actually declined from the 1993 peak of $208 million. The 2000 December year exports were $125 million, and a decade low of $85 million was recorded in 1995. Most powders and butter products are duty-free into Mexico, while cheese pays a 20 percent duty. The gains have been in the form of tariff reductions on butter and butter oil from 20 percent to zero (although the bound rates are 37.5 percent).

The Philippines

The current applied rates are well below the UR bound rates for the Philippines. For example, in the two main categories of milk powder exports the applied rates are 3 percent while the bound rates are 18 and 25 percent. Similarly for the main HS 8 line of cheese, a tariff of 3 percent is applied versus a bound rate of 35 percent.

Indonesia and Thailand

Both Thailand and Indonesia have agreed to remove quantitative restrictions on dairy imports, including the import licensing and mixing ratio regulations (WTO members have granted Thailand an extension of its mixing regime until 31 December 2003). Some current applied rates in Thailand are below pre-UR rates for dairy, and on the large value of trade for 2000 this results in gains of $4.3 million. Nearly half of these gains were in the milk powder market, where Thailand has an in-quota tariff regime with an in-quota rate of 5 percent. The rest of the gains were obtained from fresh milk, buttermilk products, butter and cheese. Exports to Thailand have doubled, from $64 million in 1994 to $141 million in 2000.

Exports to Indonesia have increased five-fold; from $43 million in 1993 to $210 million in 2000. Most of the gains of $29.7 million result from the reduction of WMP duties from 25 to 5 percent.

Sri Lanka

In 1999 New Zealand had a 66 percent market share of powder imports into Sri Lanka, and these faced a 10 percent duty.

Conclusion

Significant tariff and tariff-quota barriers restrict our dairy exports. In a recent summary of the out-of-quota tariff rates for dairy products, the US International Trade Commission (USITC) cites tariffs of 587 percent for butter and 280 percent for WMP into Japan, 299 percent for butter into Canada and 128 percent for most products into Korea[xi]. A similar situation exists in the EU. Balancing these restrictions is the relatively open access to several growth markets such as Malaysia. While gains of $131 million have been made in the dairy sector, duties of $477 million at an average rate of 11.3 percent were levied on New Zealand's dairy exports of $4.2 billion to GATT-member countries during 2000.

Overall, the global dairy market remains as one of the most trade-distorted sectors. It is worth noting in this context the universal conclusion of trade modelling analysis which clearly shows this and reinforces the fact that New Zealand would reap significant gains from further reform of the dairy sector.

4.2.2 The Meat Sector

Meat is New Zealand's second most important export sector after dairy. Total exports of meat as defined by the HS Chapter 02 were $3.69 billion in the December 2000 year. This was an increase of 26.7 percent from the previous year. In volume terms, the increase was less apparent: 740,000 tonnes in 1998 falling to 691,000 in 1999 and then recovering to 742,000 tonnes in 2000. The average price increased over the same period from $3.90 kg in 1998 to $4.32 in 1999 and to $4.97 kg in 2000. The increase was partly the result of New Zealand currency declines against the US dollar in particular and partly the result of increased lamb values in the EU in the wake of BSE and foot and mouth problems in Europe.

The two main meat markets are the EU-15 (37.7 percent) and the US (32.3 percent). Trade increased by 35 and 43 percent respectively in value terms. This was above the overall average of 27 percent from the baseline. In Japan and Canada, the next most important markets, export values declined over the period. The remarkable feature of the meat export trade is the consistency of annual export values up to the year 2000, which witnessed a dramatic increase. The value of frozen beef exports fell over the period from 1993-2000, while sheepmeat exports increased. The changes for 2000 were price-induced in the major markets, accentuated by the depreciation of the New Zealand dollar.

Chilled beef exports increased 43 percent in value over the base period, with the main increase occurring in GATT destinations. Japan took one quarter of the trade in 2000, but the US showed the largest increase by taking 19 percent. Some 90 percent of the $1.38 billion frozen beef export trade is destined for GATT members, with the US taking 70 percent of total exports. Overall the increase was 9 percent across all markets.

The EU takes most of the sheepmeat exports, with a 64 percent share by value in 2000 but a lesser 53 percent by volume. Overall, our global sheepmeat exports increased by 43 percent in value since the UR concluded, mainly due to high prices in the 2000/01 season. The value increase to the EU-15 of 38 percent was close to the overall average. The largest increase in value terms over the period was to the US.

Edible offal exports increased gradually over the period to reach $113 million. The main markets are the GATT countries of the EU-15 and Japan (one quarter each) and the US with 10 percent of exports. The EU-15 is the main venison export market with 73 percent, followed by the US with 13 percent and Switzerland with 6 percent.

4.2.2.1 The Global Beef and Sheepmeat Markets[xii]

Over the decade between 1990 and 2000, world beef trade rose by only 3 percent, while global production fell by 3 percent as consumers switched towards poultry and pork meats. The only import markets to expand have been in North Asia, in particular Japan and Korea, and, to a lesser extent, Taiwan. China is now the world's third largest beef producer after the US and Brazil, but this production is currently insulated from world trade. Over the 1990s, four major factors impacted on global beef markets:

- in Japan, a 70 percent tariff replaced import quotas instituted in 1991 with progressive reductions in tariffs to the current 38.5 percent.
- in Korea, a virtual import ban was replaced by a quota in 1988 with increases in the quota to reach a tariff-only regime of 41.2 percent in 2001.
- in Canada and the US, tariff quotas replaced quotas as a result of the UR outcomes.
- in the EU, subsidised exports were reduced by 26 percent as a result of the UR, but the import market remains virtually closed.

A fifth factor for this coming decade is that tariffs on boneless beef exported to China reduce from 31.8 percent at accession to 24.2 percent at 2002, while those in Taiwan reduce from Taiwan $24 per kg to $10 per kg over the implementation period. These reductions are not directly the result of the UR negotiations, although their conditions of accession to the WTO are in keeping with the UR commitments of other WTO members. These two markets took over 3 percent of New Zealand's meat exports in 2000, with China showing a dramatic increase from a $0.5 million base in 1993 to $25.6 million in 2000.

Other factors that impacted on the global beef market over the period included food safety scares, animal disease outbreaks, economic crises, and drought conditions in New Zealand.

Global sheepmeat trade is dominated by Australia and New Zealand which together represent about 90 percent of exports from OECD countries, with New Zealand being the more significant exporter. Developing countries with large sheep flocks include China (the world's largest producer), India, Iran, Sudan, Pakistan, Turkey, South Africa and Nigeria, but these countries largely produce for domestic consumption and have little impact on global trade. Export destinations for New Zealand sheepmeat in recent years have been dominated by the EU with a 64 percent market share, followed by the US (10%) and Canada (3%).

4.2.2.3 The Individual Meat Markets

The EU

The EU remains New Zealand's largest meat market, with a 38.3 percent share by value of meat exports in 2000 and most of this sheepmeat. Although not formally part of the UR outcome, the EU agreed to continue the Kerin/Andriessen Accord whereby the EU would not export subsidised beef to the Asia-Pacific markets of Japan, Korea, Taiwan, Singapore, Malaysia and PNG. This, along with non-UR changes to EU domestic policies, is a significant factor in world beef markets. There is also the UR outcome on export subsidies for beef to consider. In 1991/92, the EU exported over 1.3 million tonnes of beef. This was capped at 800,000 tonnes for the export year 2000.

New Zealand's sheepmeat access to the EU prior to the conclusion of the Uruguay Round was limited by a voluntary export restraint to 205,600 tonnes carcass weight equivalent (cwe) with an applied tariff of zero. This was replaced with a tariff quota of 225,000 tonnes with the tariff bound at zero (ie. an additional 19,400 tonnes at zero). Upon the accession of Finland, Sweden and Austria (FAS), an additional 1,700 tonnes was acquired on the basis of historical trade with these countries, also at the zero in-quota tariff, taking the TRQ to 226,700 tonnes cwe. In the last three December years, exports have been at the quota levels.

The gains from the UR have resulted from (a) the enhanced and secured access at bound rates of zero and (b) the gains on the extra 21,100 tonnes of sheepmeat access at zero duty. Based upon the assumption that these extra exports would otherwise have paid a 20 percent **plus** a trade-weighted average of 1,521 ECUs (Euros) per tonne tariff, we assess the latter gains at $75 million for the 2000 calender year.

There were also gains from fresh sheepmeat. Restrictions the EU applied to chilled lamb imports from NZ in 1989 (an annual increase of 1,500 tonnes per year starting at 6,000 tonnes and reaching 13,500 tonnes in 1994) were removed. With the elimination of this restraint following the Uruguay Round, exports of chilled sheepmeat increased to 18,366 tonnes in 1998, 21,687 tonnes in 1999 and 25,185 tonnes in 2000. On the basis of a calculation using the export values by the detailed HS 10 level for the comparable fresh and frozen product, the extra value to New Zealand over and above the 13,500 tonnes was some $43 million.

Total exports of frozen beef from New Zealand to the EU increased to 1995 by value, but have remained relatively steady since then. Exports in 2000 were the lowest in recent years. The global beef tariff quotas are 53,000 tonnes of frozen beef (boneless equivalent) at an *ad valorem* rate of 20%, 50,700 tonnes of frozen beef for processing (cwe) at an ad valorem rate of 20% for 'A products' (38,000 tonnes) and higher duty for 'B products' (12,700 tonnes), and 1,700 tonnes of frozen thin skirt at an *ad valorem* rate of 4%. Other TRQ volumes are country-specific allocations under the High Quality Beef TRQ at an *ad valorem* rate of 20%. Out-of tariff quota rates for beef are prohibitive in spite of reductions over the implementation period. Tariffs on beef

imports pre-UR have been assessed at 55 percent, and based on 2000 year exports, gains of $10.3 million were assessed.

The EU agreed to eliminate the 3 percent tariff applied to venison imports. On the basis of the 2000 trade, this was worth $3.85 million in duties saved.

The USA

The US is New Zealand's second most important meat market, taking some $1.2 billion in exports during 2000. This was 32.3 percent of the total, primarily exports of beef. As a result of the UR, New Zealand gained permanent access of 213,402 tonnes of frozen beef. This was 10,335 tonnes above the 1992 access, 20,223 tonnes above 1993 and 28,570 tonnes above the most recent pre-UR 1994 access. The in-quota tariff of 4.4 US cents per kg is equivalent to 2.23 percent at 2000 values. The out-of-tariff rate was set at 31.1 percent, reducing to 26.4 percent at 2000. Thus, the result has to be assessed against what it may have been in the absence of an agreement in the UR. Taking the three year average of beef sendings prior to the UR, this would indicate a saving of $49 million to New Zealand. Taking the 1994 quota, the UR gains to New Zealand increase to $70 million in 2000 (based upon the difference between the 2.23 percent in-quota tariff and the 26.4 percent out-of-quota tariff at 2000, with an average New Zealand export price of US$1970 per tonne). The latter figure is used in this paper.

From July 1999, the US applied safeguards on the importation of New Zealand and Australian lamb meat. This was successfully challenged in the WTO. While not directly a UR outcome, New Zealand was able to overturn this tariff-quota regime as a result of the disputes settlement provisions of the new WTO. The duties were reduced from 0.4 percent to 0.3 percent as a result of the UR, but at December 2000 the safeguard rate was actually 6 percent. This safeguard has not been factored into the calculation of UR gains.

The US is also a major market for venison, and the UR maintained the tariff-free access that existed at the time.

Japan

Japan is the third most important meat market for New Zealand. Japan reduced its beef tariffs from 50 to 38.5 percent over the implementation period provided global imports did not increase by more than 17 percent by volume a year. This resulted in gains of $11.2 million at 2000. Sheepmeat had tariff-free access into Japan, and this was bound. The reduction in the duties on venison from 3.5 percent to zero resulted in gains of $188,000 in 2000. Exports of meat declined overall during the period (by 7 percent). Meat exports also included by-products, which are mainly sausage casings at zero duty.

Korea

A disputes settlement case mounted against Korea in the GATT by key meat exporting members (including New Zealand) resulted in a major expansion of the Korean beef market from the global quota of 99,000 tonnes in 1993 to 225,000 tonnes at 2000, with full liberalisation after that period. A "mark-up" extra duty of 100 percent was also phased out. These results were subsequently bound in the Korean WTO Schedule, with the tariff rate reducing from 44.5 to 40 percent over the UR implementation period. Beef exports from New Zealand to Korea have declined (by value) in recent years due to the Asian economic crisis and large stockpiles of imported US frozen beef. Notwithstanding this, the reduction in duties was $1.3 million at 2000 (excluding the "mark-up"). New Zealand also benefited from the fact that Korea imported product from other exporters which may have otherwise gone to third markets, or which, in the case of the US, opened opportunities for New Zealand to replace US beef exported to Korea in the US itself.

Canada

New Zealand has access to both a country specific tariff rate quota of 29,600 tonnes and the global quota of 76,409 tonnes. Exports were 18,271 tonnes in 2000. Imports up to the access level enter duty-free while imports over the access level entered at a 26.5% tariff for the year 2000. Canada also issues supplementary permits. The supplementary permit policy is reviewed if it appears that total supplementary imports authorised when added to the TRQ of 76,409 tonnes are likely to exceed total 1994 imports which were approximately 114,000 tonnes. Prior to the UR, New Zealand had sent over 30,000 tonnes of beef to Canada at a tariff rate of 4.4 Canadian cents per kg (equivalent to a tariff of 1.5 percent in 2000), and the cessation of this tariff generated savings of $1.8 million in 2000.

Venison tariffs were bound at a zero rate, and the pre-UR sheepmeat tariffs of 1.4 percent were reduced to zero. Total exports of meat from New Zealand declined by 26 percent in value over the period, although the single-market nature of the North American market must be acknowledged.

Switzerland

New Zealand is the principal supplier of sheepmeat to Switzerland, with a 1999 market share of 45 percent. Switzerland has imposed a tariff quota of 22,500 tonnes, which aggregates red meat products (in the broadest sense) with a minimum commitment for sheepmeat of 4,500 tonnes. In-quota tariffs for chilled and frozen sheepmeat imports are liable for a 30 SFr/100 kg (gross weight) rate of duty within the red meat tariff quota. This equated to 2.8 percent for 2000. The rate of duty for out of quota product ranges from 881 to 1009 SFr/100 kg (gross weight) depending on HS category. This will phase down (by 15%) to final bound rates ranging from 749 to 858 SFr/100 kg (gross weight) over the GATT agreed period. These out of quota tariff rates equate to

about 100 percent in the case of sheepmeat. In addition, there are complex regulations associated with the importation of sheepmeat into Switzerland that include the need to purchase and market domestic product and pay different border charges. While not tariffs, these complexities add to the cost of doing business in the Swiss market.

Pre UR Swiss duties imposed on imported sheepmeat comprised a Customs duty equal to 10 SFr/100 kg, a Reserve Fund (GSF Levy) payments of 20-22 SFr/100 kg and a veterinary inspection tax of 4 SFr/100 kg. As these in total are very close to the current in-tariff quota regime rates, there do not appear to be any direct gains as defined, although there was some simplification in the import regime (including removal of the GSF levy) and the establishment of a TRQ for red meat.

Conclusions

Overall, there were significant gains from duty reductions in the meat sector (including processed meats) of $191 million on sales to GATT members of $3.35 billion during 2000. The majority of these gains came from two markets. The first of these was through secured access into the EU, where the UR delivered an estimated $90 million in duties saved. This was largely the result of enhanced access at zero tariff rates for sheepmeat. The second was the US beef market, which delivered gains of $75 million as a permanent tariff-quota regime at zero tariff rates was negotiated.

Other major gains resulted from the secured and enhanced access and zero bindings for chilled sheepmeat into the EU. These have not been included in the current analysis. Remaining duties are $125 million for an average duty of 3.7 percent. The major markets for sheepmeat and beef are the tariff-quota markets of the EU and the US respectively, and access to these markets is crucial.

4.2.3 Horticulture

Total exports of fruit and vegetables in 2000 were $1,483 million. This includes apple and kiwifruit exports of just over one billion dollars and other horticultural exports of around $478 million. The latter covers a wide variety of fruit and vegetables, with Japan as the main market of interest to this study.

New Zealand is a major exporter of only two fruits - apples and kiwifruit. In many markets Chile is the main, and sometimes only, competitor. New Zealand's exports of apples have fluctuated in value over the 1993 to 2000 period, with 2000 being some 17 percent above the 1993/94 base. Exports to the main market of the EU stayed the same, while those to the second most important market of the US increased by 54 percent by value. These two markets took 82 percent of all exports in 2000, while "tariff free" and "non member" destinations took another 13.3 percent (thus less than 5 percent went to markets, other than the EU and the US. which may have benefited from better access conditions).

For **apples**, the EU reduced its tariff from 6 to 3.8 percent during the period when New Zealand exports apples to the EU and for the generally high quality apples that

New Zealand supplies. Thus, on exports of $233.8 million in 2000, New Zealand would be saving $5.1 million in duties. There was no change to the zero duties into the US, the second main market. For Thailand a complex regime exists, but the net result is a gain of $1.6 million from apple exports. Duties into Malaysia reduced from 10 to 5 percent, resulting in savings of $0.53 million on exports of $10.6 million.

For **kiwifruit**, exports from New Zealand stagnated in the mid 1990s when the industry faced an economic downturn. The industry had recovered by 2000 - exports were 63 percent by value above the base period. The EU is still the main destination, taking 53 percent of the total by value in 2000. Japan, taking 26 percent, is next, followed by Australia and Korea. The EU reduced tariffs from 11 to 8.8 percent for savings of $9.1 million. Japan reduced duties from 8 to 6.4 percent, resulting in a gain of $2.5 million. The US reduced duties from 8.5 percent to zero for a gain of $3.2 million, while Korea reduced its duties from 50 to 45 percent for a gain of $0.4 million.

Some $260.5 million of the total of $478 million of "other" (non apple and kiwifruit) exports were exported to GATT members[xiii]. Several of the main exports to Japan have duties reduced by 2 to 3 percent over the implementation period (from levels at the start of 5 or 10 percent). This resulted in reduced tariffs of $4.6 million in 2000 on exports of $229 million to Japan. The main beneficiaries are exporters of squash, onions and berry fruits. Similarly, exporters of onions to the EU benefit from the reduction of duties from 12 to 9.6 percent over the period for a gain of $1 million.

This gives a total estimated gain of at least $33.2 million in the fruit and vegetable sector from reduced duties. In addition to the tariff barriers, there are significant non-tariff barriers (SPS) which impede access for New Zealand products.

4.2.4 Other Agricultural Sectors

4.2.4.1 Hides and Skins

Total exports at June 2001 were $833 million (including a small amount of processed leather). One quarter of the trade is with tariff free or non member economies. Duties in the EU are currently at zero, and were zero before the UR. Korean duties were reduced from 3 to 1 percent as a result of the UR, leading to a saving in duty of $3.1 million. Exports to Japan were free pre-UR and have been bound at free. Rates into Turkey were at 60 percent and have been bound at 36 percent, but most of the trade was entering Turkey duty-free, and the remainder was well below the bound rates. In Mexico, rates are bound at 9 percent but almost all of the trade enters duty-free and did so pre-UR. Exports to Thailand face a bound duty of 27 percent, but enter duty-free.

4.2.4.2 Wool

Prior to the Uruguay Round, international wool trade was already occurring at low or zero tariffs, with few trade restrictions. Wool exports totaled just over $1 billion for the December 2000 year. Thirty seven percent of this trade was with tariff free or non-GATT members (China, Australia, Nepal, Iran, Hong Kong and Taiwan). Another 40 percent was with the EU, where all wool fibre tariffs were already at zero. Similarly, exports to Japan were duty-free pre-UR and these rates have been bound. In the US, most wool imports have been duty-free since 1992. The exception is fine wool of less than 28 microns, where the duty was reduced from 22.0 US cents per kg to 18.7 US cents per kg. This resulted in a possible gain of $170,000.

Turkey agreed to reduce its bound rates from 20 to 8 percent over the period, but the current and historical applied rates are zero. A similar situation exists in Thailand, where the bound rates were halved to 15 percent but the current applied rates are 1 percent. All wool imports into Canada are free and were free pre-UR. The Indian import regime is complicated. There is a tariff (including all the add-ons) of 25 percent on almost all of the $63 million exports from New Zealand. The base rate at 1986 was 20 percent, which means there was a notional loss (ignoring historical add-ons) as calculated here of $3.0 million[xiv].

The notional result for the sector is a $1.8 million loss once the increased duties into India are factored into the equation. There were no global quota problems in the sector. It was anticipated that a liberalisation of the textile and clothing sector may have an effect on the wool trade through increased international demand, but this has not been examined further. China's recent admission to the WTO will result in a significantly improved access regime for the export of wool to that market. These gains fall outside the ambit of this report and are not assessed here.

4.2.4.3 Beverages and Liquor

Beverages and liquor accounted for $350 million of exports in 2000, a figure double 1998 exports of $175 million and nearly four times 1994 exports of $91.6 million.

Most of this increase has been in wine, where 2000 exports reached $196.8 million. Tariffs on alcoholic beverages are often complex. Only the customs duties and not excise duties are assessed here, as both domestic production and imports pay a common excise. The EU continued to be the main market in 2000, and agreed to reduce tariffs from 5 to 4 percent over the implementation period for most of the trade. This resulted in gains of $1 million. The next most important market is the US, where the contractual agreement in the UR was to reduce tariffs by 36 percent or from 6 to 3.82 percent for a gain of $0.8 million. In Canada, wine tariffs fell from Canadian $0.44 per litre to Canadian $0.374 per litre for sparkling wines. There was no difference to the New Zealand preferential tariffs on still wines.

Non alcoholic beverages were the second most important export, worth $77.1 million for 2000. Most (86.1%) went to Australia, with South Africa the second most important market. Similarly for the third main export, ethyl alcohol, over 90 percent of the $41.5 million in exports went to Australia and Hong Kong. The final category is the $18 million in beer sales, where the markets of the US, the EU, Canada and Japan all agreed to a "zero for zero" outcome on beer with the customs tariffs on beer eliminated in stages in signatory markets. This accounts for 77.5 percent of New Zealand 2000 exports (with Australia and the Cook Islands making up another 15.3 percent). Pre-UR duties into the main market of the US ($11.2 million or 62.6% share) were US$0.016 per litre. An assessment has been made that this represented 3 percent duty rate and therefore the removal constitutes a saving of $300,000. Duties into the EU were 5 percent, representing savings of $90,000.

Overall, a duty savings, as calculated, of $2.3 million resulted from the UR, with most of this on wine sales into the EU.

4.2.4.4 Live Animals

Exports were worth $150.3 million in 2000. Just over 90 percent were to "tariff free" markets (Australia, 72.5% and Hong Kong 4.7%), and the remainder principally to the US, Canada and South Africa where rates have historically been zero. Other markets are Malaysia and Mexico, where concessions of 1 percent were made on some lines, and to the EU where duties reduced from 18.5 percent to 11.5 percent for very small savings of $122,045.

4.2.4.5 Other Agricultural Exports

Remaining components of the agricultural trade comprise a variety of exports from cereals to processed foods (including fruit juices) to pet foods. It also includes ice cream. GATT member trade of $543.5 million was analysed, and gains of $29.1 million were calculated while remaining duties were $61.3 million (11.2%).

Japan was the main market, with exports of $301.5 million and gains of $28.3 million. Most of these gains were recorded on exports of "chocolate and other food products", where the duties on exports of $40 million reduced from 36 percent to zero for gains of $14 million. Duties on protein concentrate (a dairy product, but included here in "other") were reduced from 35 to 25 percent, and this gained $1.8 million on the trade of $18.2 million. Processed (tinned) beef tariffs were reduced from 33.2 to 21.3 percent for a savings of $2.9 million on exports worth $24.5 million. Other gains of over one million were recorded in cocoa products and apple juice.

Most of the remaining gains ($1.2 million) were recorded in the Korean market, with gains in processed beef. Protein concentrate (a milk product) into Canada and a mixture of products into Malaysia are the other reportable gains.

5 Non-Agricultural Merchandise Exports

Exports of **non-agricultural** products as defined by the WTO reached $14.4 billion[xv]. Of this, $1.4 billion or 9.8 percent was fish and fish products. Of the remaining $13 billion, 30.9 percent went to Australia, 3.5 percent to China, 3.1 percent to Hong Kong, 1.8 percent to Taiwan and 1.5 percent to Singapore. Thus, at least 40 percent was to "tariff free" or non member economies. Export shares to the main GATT member economies were 18.2 percent to Japan, 13.2 percent to the US, 6.6 percent to Korea, 7.2 percent to the EU and 1.2 percent to Malaysia. For definitional purposes "passenger effects" (ie, goods in personal luggage) is deemed to be a destination, and this accounted for 1.2 percent of non-agricultural exports.

By commodity, $1.4 billion was fisheries product, $3.2 billion forestry product, $1.98 billion machinery (HS 84 and 85), $1.3 billion aluminium and $556 million petroleum products.

As with the agricultural exports, MFAT has undertaken analysis on all tariff lines representing exports worth over $1 million at the detailed HS 8 level for the December 2000 year.

Table 3: Non-Agricultural by Export Destination. (GATT members)

Destination	Exports 2000	Duties	Gains $	Av duty %
Total	**6,657.6**	**133.4**	**128.0**	**2.0**
Japan	2,394.7	28.8	38.0	1.2
Thailand	119.0	3.2	22.4	2.7
Korea	904.2	21.2	17.8	2.3
EU	909.0	26.5	16.0	2.9
USA	1,538.6	10.8	14.0	0.7
India	64.5	3.6	6.0	5.6
Philippines	87.7	4.5	5.1	5.1
Canada	104.4	0.5	2.5	0.5
Malaysia	110.8	3.7	1.6	3.4
Mexico	118.0	11.0	1.2	9.3
South Africa	27.3	0.04	2.0	0.0
Indonesia	132.0	1.4	1.0	1.1
"Other"	141.6	17.9	0.02	12.6

Table 3 shows the main destinations of the exports analysed. On exports of $6.7 billion gains from **reduced duties of $128 million** were recorded. These gains were concentrated in Japan ($38 million) and Thailand ($22.4 million). The average duty on the 2000 exports was a relatively low 2.0 percent. Overall the gains were almost as much as the remaining tariffs, showing that tariffs have almost halved over the period. This result is also true for most of the sectors represented here. Given the importance of the duty-free Australian, Singapore and Hong Kong markets in manufactured goods trade, this figure of 2.0 percent for the average duty on the exports of manufactured goods to all destinations would reduce to less than 1.5 percent when total exports are considered.

Table 4 shows the gains by sector. The big gainer is the forestry sector, with gains of $27.8 million. This is followed by fish and the catch-all "other" sector which encompasses a wide range of exports. "Confidential" exports record gains of $21 million, with most of these gains coming from methanol exports.

Table 4: Non-Agricultural by Sector (GATT members)

Sector	Ex 2000	Duties	Gains $	Av duty %
Total	**6,657.6**	**133.4**	**128.0**	**2.0**
Forestry	1,880.3	31.5	27.8	1.7
Aluminium	991.3	5.5	14.3	0.6
Fish	871.0	36.0	23.0	4.1
Other manufacturing	774.7	15.8	17.6	2.0
Confidential	642.2	12.3	21.1	1.9
Electrical	349.6	6.8	8.8	1.9
Aircraft	333.2	9.5	0.3	2.9
Machinery	290.9	6.4	7.5	2.2
Fuels minerals etc	220.9	2.7	2.8	1.2
Iron/steel	173.6	6.2	4.5	3.6
Vehicles	129.8	0.8	0.3	0.6

5.1.1 Fish and Fish Products

The industry produces around 650,000 tonnes of seafood annually, and more than 90 percent of revenue is from export sales. Fish and fish products as defined in HS Chapter 03 reached $1.28 billion in 2000, a level up some 18 percent from the 1993/94 base period. Exports of prepared fish products in Chapter 16 reached $121 million in 2000, putting total export sales at $1.4 billion. However, an analysis of the prepared products shows that some 79 percent went to the three "tariff free" economies of Australia, Hong Kong and Singapore. Gains from the UR were limited to $680,000 from for prepared fish products into Japan and Malaysia. Analysis will therefore concentrate on the HS Chapter 03.

The reasons for the lack of expected growth in fish exports are complex. The expected international price rise following the collapse of Canadian and US eastern fisheries did not eventuate, and supplies elsewhere increased as governments provided subsidies to their fleets. New Zealand produces around 1 percent of global fish products and trades around 2 percent. New Zealand is therefore a small player with limited market power. The industry estimates that the average tariff is 3 percent, or about $42 million in added costs. MFAT analysis on exports to **all** destinations that were worth at least $1 million at the HS 8 digit level in 2000 shows that the average duty was 4.2 percent ($53.75 million on exports of $1,299.7 million).

The estimated gains from the UR were at least $23 million. Of the $54.6 million in duties paid on total exports to all destinations at 2000, $18.9 million was paid at the EU border (8.8% average duty), $12.3 million into Japan (4.0%), $9.93 million into Taiwan (39%), $9.9 million into China (20%) and $3.9 million into Korea (10.3%). Using more

recent March 2001 trade data, MFAT analysis calculated that, while not an outcome from the UR, fisheries sector gains from the accession of China and Taiwan will be worth $11.14 million. This is close to the gains from GATT members.

A concern to the industry is the level and widespread use of subsidies internationally.[xvi] Although the impact of these subsidies is complex and controversial, they are significant in increasing catch and contributing to lower world prices in the short to medium term. In the longer term they can lead to excess harvesting and resource depletion. These subsidies were not adequately disciplined in the UR negotiations on industrial goods, but this is being remedied by specific inclusion at New Zealand's instigation of fisheries subsidies for negotiation in the forthcoming Doha Development Round of the WTO. Similarly, quotas remain on Japanese squid and EU whitefish such as hoki. The complexities of the HS codes for fish are an added complication: imports can be isolated into a unique HS code based on species differentiation. This is frequently done in a manner which discriminates against imports of similar fish species from different sources.

Exports and Gains by Market

Twenty three percent of exports in 2000 went to the no-tariff markets of Australia (11.6%), Hong Kong (10.4%) and Singapore (1 percent). Another 7 percent went to non-member economies. Thus, one third of the trade can be removed from the analysis of the UR gains.

Japan is the main market, with $307 million of the export trade. Exports into Japan in 2000 faced an average duty of 4.05 percent. Pre-UR this would have been 5.3 percent, giving a duty saving of 1.2 percent or $3.8 million. There were no access gains by way of quota relaxation from Japan.

The USA is the second most important market. Most products enter duty-free, and the average duty in 2000 was a minimal 0.1 percent.

Exports to the EU increased by 90 percent over the period, and the EU was the destination of exports worth $215 million in 2000. The average duty paid in 2000 was 8.7 percent, down 3.5 percentage points from the pre-UR situation. The gains were therefore $7.5 million in reduced duties for the 2000 year, in the form of the reduction of duties from 15 to 7.5 percent in the main trade of fresh and frozen whitefish such as hoki.

In 2000, Korea took product worth $37.8 million. As a result of the UR, Korea halved most of its duties over the implementation period, and as a result the duties reduced to $3.9 million for an average level of 10.3 percent. The savings may overstate the situation as some of the tariff concessions made by Korea were actually in place pre-UR. Modest gains of $38,000 were made into Malaysia, while tariffs into Thailand were below the 5 percent bound rates. Canadian tariffs continue to be zero.

5.1.2 Forestry Products

The radiata pine plantation harvest of 18.6 million cubic metres in the year to June 2001 is forecast to increase by 24 percent by 2005 and grow a further 56 percent by 2020 to reach 36 million cubic metres. Due to the limited size of the New Zealand market any increase in production needs to be exported. To maximise benefits to the New Zealand economy, a major co-ordinated push is required to develop current export markets and to find new ones for those wood products that provide a higher return.

The New Zealand forest industry provides 4 percent of New Zealand's GDP and currently is the largest earner of non-agricultural merchandise export returns. During the December 2000 year, exports totaled $3.26 billion. Fifty eight percent or $1.88 billion have been included in the GATT member market analysis. Another 37 percent was destined for the main tariff-free markets or non-GATT member economies, with Australia being the largest market overall. Since 1993 forestry products, as measured by the dominant exports of HS 44, 47 and 48 (logs/wood, pulp and paper and paperboard products respectively) declined from 12.85 percent to 11.6 percent as a percentage of New Zealand's merchandise exports. This percentage should increase as additional supplies come on-stream in New Zealand.

The main export sector by value was HS Chapter 44, logs and processed timber. Exports analysed in this Chapter totaled $1.44 billion, divided between $684 million in logs and the remaining $755 million in sawn timber and general processed products such as particle board. Log exports were effectively duty-free into all markets in 2000; remaining duties on logs were only $133,400. Gains of $7.7 million were recorded in the log trade, with most of these gains recorded in India and Korea, as most other markets were duty-free pre-UR. Gains of $14.5 million were recorded in the further-processed components of HS 44, while duties of $20.5 million or 2.73 percent remain. Over half of the latter gains were recorded in the Japanese market.

Japan was the main GATT member market, and gains of $8 million were recorded on exports of $724 million. The remaining duties were $15.6 million or 2.2 percent. Almost all of these gains were recorded in the export of particle board and plywood, where the duties fell from an average of 4.27 percent on exports of $365 million. The remaining gains of $0.24 million were recorded in pulp exports, where the duties went to zero from 0.3 percent.

The next largest gains of $5.4 million were recorded in **Thailand**. The duties on both logs/processed timber and pulp were reduced to 1.0 percent from 15.9 percent and 10 percent for logs/processed timber and pulp respectively.

Duties in the **Philippines** reduced by more than 50 percent for gains of $4.5 million on exports of $63 million. These gains were spread between logs/processed timber, where duties reduced from 10.7 percent to 4.9 percent and, in contrast to all other markets, in the paper and paperboard markets where gains of $2.3 million were recorded as duties reduced from 20 percent to 8.4 percent on exports of $19.8 million.

Korea recorded gains of $4.3 million on exports of $461 million. The average tariff reduced to 0.7 percent from 1.64 percent. Most of these gains were recorded from the export of logs, where duties reduced to zero on exports valued at $342 million. Lesser gains were recorded in pulp exports, where duties reduced from 2.0 percent to 1.2 percent, and minor gains were recorded in processed paper and paperboard exports (where the average duty on exports of $10 million reduced from 8.0 percent to 6.0 percent.

The other market where gains of over one million dollars were recorded was the Indian market. Duties on logs were reduced from 15.1 percent to 1.3 percent. Some gains were made in both the Indonesian and US markets, and remaining duties in both were 0.6 percent in the case of Indonesia and zero in the US. Small gains of $328,000 were recorded on exports of $49.5 million to Malaysia.

In **conclusion**, valuable gains of $28 million were made in the forestry sector, with most achieved in the export of logs/processed timber. These gains almost matched the remaining duties of $31.5 million or 1.7 percent.

A problem in the forestry sector is "tariff escalation", where tariffs are zero or low on the raw materials (logs) and then increase (escalate) as the primary products undergo additional processing.. The New Zealand Wood Processing Strategy (WPS) was set up by Government to remove impediments to the development of wood processing in New Zealand. As part of this initiative the Trade Access Group was set up to build support for a new WTO round, identify opportunities to advance trade at the bilateral and multilateral levels, and identify ways to address non-tariff barriers. The Asian markets of Japan, China, Taiwan, the Republic of Korea (ROK) and India have been identified as key markets where tariff escalation and non-tariff barriers protect local production and restrict imports of value-added wood products.

5.2 Non-agricultural Gains by Market

The gains in **Japan** of $38 million came primarily from five sectors:

- fish, $3.8 million.
- forestry, $8 million, mostly in plywood and fibreboard.
- "confidential", $12.9 million (mostly from a reduction of methanol tariffs from 4.9 percent to free).
- aluminium, where a reduction from 1.0 percent to free resulted in gains of $7 million.
- mineral fuels, $2.3 million.

The gains of $22.4 million into **Thailand** came from mostly three sectors:

fish products, $10.2 million.

forestry, $5.4 million.

confidential, $1.5 million.

Gains of $18 million in **Korea** came from four main sectors:

- forestry, $3.8 million.
- aluminium, $5.8 million where duties reduced from 10 to 5 percent.
- "confidential", $6.5 million reductions in (mostly) methanol duties from 10 to 5 percent.
- and fish products, with reductions of $1 million.

Other gains ($30 million) came from the EU and US markets. In the **EU** the gains are spread relatively evenly across a large number of trade lines. Fish is the main sector, with gains of $7.5 million. Similarly, gains in the **US** market came about from reduced tariffs on several different export lines - with many of these reduced to and bound at zero.

[i] Unless otherwise stated all values are expressed in New Zealand dollars.
[ii] These classifications are based on the Harmonised System (HS) of trade classification. HS codes 01 to 24 (but excluding HS 03 and parts of 16, fish and fish products) and parts of HS 41, hides, HS 35 caseins, and HS 51, wool fibre, are classified as agriculture. The remainder, including fish and fish products, are classified as industrial (ie., non-agricultural). The HS classification is now used by almost all countries. It is represented in the form of a tree, with smaller and smaller branches defining more detail in the classification. For example, HS 02 is meat, and these HS 2 levels are known as Chapters. At the next level HS 0202 (the HS 4 level) is frozen beef. The HS 6 level code HS 020210 is frozen beef carcasses and half-carcasses, and so on in more detail through the HS 8 and 10 levels in many cases. The HS lines through to the HS 6 level are internationally comparable, while those at the HS 8 and HS 10 levels are applied by the individual country and may not match internationally.
[iii] "Trading Ahead: the GATT Uruguay Round: Results for New Zealand", MFAT.
[iv] Details of New Zealand's exports by commodity for the June 2001 year are available on www.mfat.govt.nz/foreign/tead/trdstatsjune01/commodity tablesprincipalexportse
Although the June data series is not the same time period as that used in the current report it is a useful reference point, while the December 2001 data provides an update on the most recent trade.
[v] Traders may elect, for commercial reasons, to ask Statistics New Zealand to suppress details of their imports or exports for up to 12 months. Examples of exports currently being classified as "Confidential" include methanol, coal, wood pulp, clay, sphagnum moss, mushrooms and some iron and steel products. A full list of the goods classified under this heading is available on the Statistics New Zealand Webpage (www.stats.govt.nz). The value of "Confidential" trade is considerable - exports of $1.03 billion for the December 2000 year.
[vi] "Dairy production in Selected Countries",

USDA Website www.fas.usda.gov/dlp/circular/2000/00-07Dairy/dairyprd
[vii] "The OECD Agricultural Outlook", March 2001.
[viii] Binfield et al, "The Impact of WTO Export Subsidy Reductions on Agricultural Output, prices and Farm Incomes in Ireland", on www.fapriireland.teagasc.ie/fapri/pubandrep This analysis estimates that world dairy prices for milk powders will be 8 to 9 percent higher and cheese 2 percent higher than they otherwise would have been at 2010 under the mandated UR export subsidy reductions. The butter price is actually lower as "too much" butter is produced to meet the higher demand for SMP. There is little quantitative analysis on the impact of the reductions in EU export subsidies to date, although, for a variety of reasons, those impacts would be modest. The big gains are to come.
[ix] "Profiles of Tariffs in Global Agricultural Markets", ERS of the USDA, January 2001.
[x] where the ECU is the European Currency Unit, an artificial currency developed for EU administrative use. It was replaced by the Euro, a real currency unit, from 1 January 2002.
[xi] An indication of just how important these levels are for New Zealand's trading interests can be seen in the publication "The Relative Tariff Ratio", on www.nzier.org under the New Zealand Trade Consortium Papers series.
[xii] This section draws on the "Magellan Project" by the CIE in Canberra, August 2001 for beef and from Meat New Zealand's Global Analysis on www.meatnz.co.nz for sheepmeat.
[xiii] This paper uses analysis is at the HS 8 digit level. Given the numerous small product lines in the "other" exports and the million dollar cut-off used in this study, only a little over half of the trade is considered in this paper.
[xiv] We have been unable to verify the add-ons which may have also been a feature of the Indian tariff in 1986, thus the loss here may be overstated. If so, the overall gains become higher.
[xv] Based on June 2001 data.
[xvi] The OECD estimate that government transfer to the fishery sector were some $5.6 billion US dollars in 1999. This represented 18 percent of the value of the OECD catch.

Trade and Technological Change: The Case of Milk Protein Concentrates

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Outline

- Background
- Simple dairy chemistry and the UF process
- Four classes of milk protein imports
- Protein imports, producer price of milk, and CCC purchases
- Potential US policy reactions
- Model
- Analysis of casein production subsidy

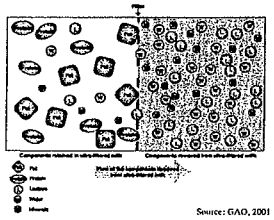
Background

- Work in progress
- MPC v SMP/NDM
  - —Basic milk chemistry — fat, protein, lactose
  - —Exploits advances in ultrafiltration technology
- MPC a contentious issue
  - —Wet versus dry use in cheese plants
  - —A new product with new uses or simply a substitute for an old one?
  - —Imports increased dramatically since mid-1990s
    - WTO loophole?
  - —Impact on CCC purchases and farm price?

Simple Dairy Chemistry

- Typical raw milk composition
  - —US: fat 3.7%, protein 3.3%, lactose 4.8%, ash 0.7%
  - —NZ: fat 4.7%, protein 3.6%, lactose 4.9%, ash 0.8%
- Standardise raw milk for cheese making
  - —Casein:fat ~0.7 for cheddar; varies by variety
- MPC
  - —40% - 90% protein, 46% - 3% lactose
- SMP/NDM
  - —~36% protein, ~52% lactose
- Casein/Caseinates
  - —90%+ protein, <0.2% lactose

The UF Process

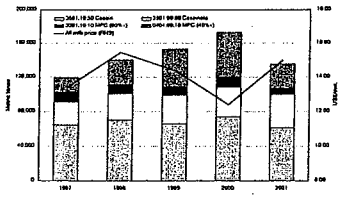


Source: GAO, 2001

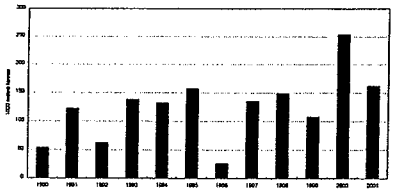
Four Classes of Protein Imports

- HS 3501.10.10 — Casein, MPC
  - —Essentially any complete milk protein other than casein, e.g. MPC with 90%+ protein
  - —No quota; tariff = 0.37¢/kg, i.e. US$3.70/tonne
- HS 3501.10.50 — Casein other than MPC
  - —No quota; no tariff
- HS 3501.90.60 — Caseinates
  - —No quota; tariff = 0.37¢/kg, i.e. US$3.70/tonne
- HS 0404.90.10 — MPC
  - —Any complete milk protein that is more than 40% protein by weight (def. allows blends)
  - —No quota; tariff = 0.37¢/kg, i.e. US$3.70/tonne

US Milk Protein Imports and Milk Price



CCC Purchases of NDM



Potential Policy Responses

- TRQ on MPC or on all Casein/MPC classes
  - —HR 1786 and S 847
- Convert NDM to Casein
  - —USDA/FAS D&DOD-105
  - —Use CCC stocks of NDM
  - —Essentially a subsidy
- Direct subsidy for casein production
- Trade law remedies
  - —e.g. countervailing duties, antidumping, etc.

Model

- Detailed US dairy sector model
  - —Multi region
  - —Multi product
  - —Farm —processing —demand market levels
  - —Multiple component pricing
  - —Administered pricing formulae (CA and FMMO)
  - —TRQs on imports
- Formulated as a mixed complementarity problem

Analysis of Casein Production Subsidy

- Very preliminary!
- CCC purchases of NDM decline
  - —US$320m in 2001 or half the total without the subsidy
- DEIP expenditures decline
- Casein imports decline by about one half
  - —i.e. about $100m
- Price of protein in US increases
  - —Cheese market impacted negatively
- Re-allocation of milk solids

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OECD AGRICULTURE AND NEW ZEALAND
(From bean-counting to free-trade?)

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SUMMARY

The OECD has an active work programme on agricultural and trade policy that is of interest and value to New Zealand. Work undertaken within the Directorate for Food, Agriculture and Fisheries includes monitoring and evaluating agricultural policies; outlook for agricultural markets and trade; trade liberalisation; environmental sustainability; food safety; and structural adjustment of the agro-food sector.

This paper outlines some elements of the work programme, the analytical tools used, some issues under current scrutiny, results and insights achieved, and comments on the ways in which New Zealand agricultural economists and researchers have been involved with the agriculture work of the OECD.

Keywords: OECD; agriculture; trade; policy reform

Introduction

The Organisation for Economic Co-operation and Development (OECD) is an inter-governmental organisation founded in 1961, the aims of which are to promote policies designed to:

- achieve the **highest sustainable economic growth and employment** and a rising standard of living in Member countries, while maintaining financial stability and thus contributing to the development of the world economy;
- contribute to **sound economic expansion in Member countries as well as non-OECD economies** in the process of development;
- contribute to the **expansion of world trade on a multilateral, non-discriminatory basis,** in accordance with international obligations.

The OECD brings together its **30 Member countries** (Annex 1) to discuss the broad economic, social and environmental policy concerns of governments. The OECD provides sound and objective policy analysis, and enables dialogue and peer review between Member countries. Member countries share their experiences, seek answers to common problems, work to co-ordinate domestic and international policies, and engage non-member countries in constructive dialogues in an increasingly globalised world.

The Organisation has become one of the world's largest and most reliable sources of comparable statistical data with information covering all sectors of the economy. The data received from governments are harmonised to facilitate comparison and analysis.

Benefits to New Zealand

Membership of the OECD affords a unique opportunity for New Zealand to participate on a regular basis with a group of influential developed countries in the exchange of information about most aspects of government policy. The annual OECD Economic Outlook and regular country reviews provide useful economic assessments of member economies. More importantly, membership gives us a voice in deliberations concerning the management of the international economy. OECD membership helps to reinforce at a working level our links with our major trading partners and such important industrialised economies as the EU, the United States and Japan. A key area of interest for New Zealand is that of agricultural policy reform and trade liberalisation, outlined below.

Committees

Member countries meet and exchange information in committees. They bring together representatives of member countries, either from national administrations or from their permanent delegations to the OECD, located in Paris. The most powerful body is the Council, which has the decision-making power. The Council meets regularly at the level of ambassadors to the OECD to give general guidance to the Organisation and its work; and also meets at Ministerial level once a year, when foreign, finance and other ministers from member countries discuss important issues and set priorities for OECD work over the coming year.

Specialised committees meet to advance ideas and review progress in more tightly defined areas of policy, such as economic policy, trade, science and technology, development assistance, **agriculture** or financial markets. There are about 200 committees, working groups and expert groups in all. Committees define the elements of the work programme, which is undertaken by the professional staff of the Secretariat (Annex 2).

Committee for Agriculture

The **Committee for Agriculture** is one of the major policy committees of the OECD. It implements the agriculture programme of work, which is approved by the Council. It oversees both the content and the running of the programme and provides a forum for Member governments to address common problems, exchange experience and encourage co-operation on new approaches to policies. From time to time, the Committee meets at High level or at Ministerial level to provide further impetus to the process of agricultural reform.

The Committee for Agriculture is assisted by several Working Parties and Commodity Working Groups, which deal with the detailed design and implementation of specific aspects of its work. It has also established links with other OECD Committees, in particular the Environment Policy Committee and the Trade Committee, through Joint Working Parties. The Global Forum on Agriculture promotes a two-way policy dialogue and the sharing of knowledge with non-OECD countries. Expert workshops and seminars are organised regularly on special themes and topics.

The Committee also draws upon and feeds into the work of many other international institutions, notably the FAO, WTO, World Bank, and Council of Europe. The international farm organisations are consulted on issues of common interest and on ongoing activities on a regular basis. Consumer organisations, agri-business, farm organisations, and environmental non-governmental organisations, are also invited on an *ad hoc* basis to conferences and workshops on specific topics. Key academic and research institutes are also important partners in this respect.

Directorate for Food, Agriculture and Fisheries www.oecd.org/agr/

The work of the Committees and Working Parties is supported by the **Directorate for Food, Agriculture and Fisheries** in implementing the programmes on agriculture and on fisheries. The staff of the Directorate is part of the Secretariat of the OECD and are independent civil servants drawn from OECD Member countries. The current Director (since February 2002) is Professor Stefan Tangermann. The Directorate is served by five Divisions and two Units: Trade and Markets; Policies, Trade and Adjustment; Policies and Environment; Non-member Economies; Fisheries; Codes and Schemes; and Co-operative Research.

It was the work of this Directorate that was instrumental in quantifying the extent of agricultural subsidies in OECD member countries, and their detrimental impact on agricultural trade. Professor Bruce Ross was appointed to head the quantitative analysis work developed and undertaken within the Agriculture Directorate, as part of the Ministerial Trade Mandate, initiated in 1982. This work underpinned the 1987 Ministerial Council Meeting, which established the **1987 OECD Ministerial Principles for Agricultural Policy Reform.** These Principles, coupled with the analytical results of the OECD's work, provided a basis of understanding and a set of guidelines for the subsequent GATT Uruguay Round Agriculture negotiations, and provided a framework for the successful negotiation of reductions in levels of production assistance and export subsidies.

The 1987 Principles called for:

Progressive and concerted reductions in levels of support and improved market orientation, through reliance on less distortionary forms of support and reduced insulation of domestic production from world market price signals.....A gradual and multilateral movements in this direction across OECD countries would ease the burden of adjustment since the impact would be spread over time and across agricultural commodities and countries.

Since these principles were promulgated they have been regularly reiterated. There has been some reorientation of support away from market price support and towards direct payments to farmers, but little actual reduction in total support levels, as measured by the aggregate measure of support now known as the Producer Support Estimate (PSE). Since the mid-1980s only modest progress has been made, the reform process is fragile, and much remains to be done. Support levels provided to agriculture in the OECD area remain high, trade distortions are perpetuated and agricultural policies do not always achieve their intended objectives.

The Directorate calculated that it cost consumers and taxpayers about USD 311 billion to subsidise the farm sector in 2001, or 1.3% of GDP in the OECD area. Even with agreement to cut those subsidies, much work remains in implementing cuts efficiently and fairly, and finding ways to help the farmers that will lose out.

The Directorate reports on agricultural policy reform and market trends in its annual publication *Agricultural Policies in OECD Countries: Monitoring and Evaluation*. It considers policies for making agricultural production and marketing more efficient, and looks at the links with the environment and rural development. It also establishes and manages codes for international standards for fruits and vegetables, seeds, forest reproductive material and tractor-testing in order to promote trade. Also, the Directorate supports the work of the Global Forum on Agriculture, which engages in dialogue with non-member emerging and transition economies (ETEs), undertakes policy reviews and analyses, and examines issues of joint interest to Members and ETEs.

In 1998 OECD Ministers of Agriculture reaffirmed their support for "the long-term objective of substantial progressive reductions in support and protection. They also agreed other shared goals relating to food safety, food security, environmental protection, and rural viability (Annex 3).

Work Programme of the Committee for Agriculture

The main activities of the Committee for Agriculture, which is serviced by the Directorate for Food, Agriculture and Fisheries, are the monitoring and evaluation of agricultural policies in Member countries, with a view to encouraging structural adjustment, the adoption of market-oriented policies and the removal of obstacles to international trade. OECD Member governments have repeatedly expressed their commitment to formulating policies based as far as possible on the free play of market forces and to pursuing objectives which reflect societal concerns within increasingly interdependent economies.

There are currently six broad 'core' activities within the Committee for Agriculture work programme:

1. Monitoring and evaluating agricultural policies
2. Assessing future developments in agricultural markets and trade
3. Evaluating and strengthening the process of trade liberalisation
4. Assessing ongoing and emerging challenges to further trade liberalisation

5. Enhancing the environmental sustainability of agriculture
6. Analysing the interface between domestic and international issues and policies.

[Further details of the work programme are outlined in Annex 4.]

Also, at the request of G8 leaders, and OECD ministers at their 2000 Ministerial Council Meeting, a work programme on food safety has commenced. Although a horizontal activity across several Directorates, the work is managed from the Agriculture Directorate, and covers issues related to trade and economic impacts, modern biotechnology, regulatory issues and socio-economic concerns.

Recent analytical work has included an evaluation of the Uruguay Round Agreement on Agriculture; production, trade and income effects of different crop support measures (using the PEM analysis); tariffs and tariff rate quotas; export credits; export subsidies; State trading enterprises; China's agriculture in the international trading system; agricultural policies in Bulgaria, Romania and Slovenia; modern biotechnology and agricultural markets; decoupling (a conceptual overview); an analytical framework for multifunctionality; low incomes in agriculture; appellations of origin and geographical indications; agri-environmental indicators; agri-environmental policy issues; and issues in sustainable agriculture.

Some of these publications are available from the OECD Agriculture website at www.oecd.org/agr

Tool Box

The Secretariat employs a small but well-developed box of tools with which to carry out its analytical work.

The main tool used in evaluating policies is the internationally-recognised indicator of support – the **Producer and Consumer Support Estimates** (PSE, CSE), which was developed in the OECD and has been in use since 1987.

- Producer Support Estimate (PSE) adds up the cost of support **to farmers** from trade barriers that keep domestic prices above those on the world market (paid by consumers) plus budgetary payments and input subsidies (paid by taxpayers).
- Consumer Support Estimate (CSE) adds up the cost of support paid **by consumers**.
- Total Support Estimate (TSE) adds up the cost of consumer and taxpayer support to agriculture **as a whole** (hence also including sector-wide research, infrastructure, inspection, marketing and promotion).

The PSE/CSE and related indicators are expressed in absolute and percentage terms by country and by commodity, and trends monitored and evaluated in relation to policy developments. Derivative indicators, such as the **Nominal Protection Coefficient** (NPC) and **Nominal Assistance Coefficient** (NAC) are used as indicators of the degree of protection and market orientation.

In 2001, support to OECD agricultural producers as a share of total farm receipts (%PSE) was 31 per cent, with levels ranging from very low in New Zealand (1%) to very high in Norway (67%) and Switzerland (69%). Across commodities, the PSE was highest for rice (81%), sugar and milk (both 45%) and less than 20% for wool, pigmeat, poultry and eggs. Total support to agriculture (TSE) amounted to USD 311 billion, or 1.3% of GDP, in 2001.

Although there are differences between them, the methodology and classification of the PSEs formed the basis for the development of the AMS (Aggregate Measure of Support), used by the WTO to establish legal commitments and to monitor compliance with undertakings on domestic support agreed in the Uruguay Round.

As well as monitoring the trends in the overall levels of support, the OECD also provides a comprehensive breakdown of the way in which that support is delivered. Although these (basically accounting) indicators do not measure, by themselves, the levels of the associated effects or distortions, they provide the necessary data and information for the quantification of the production, trade and farm income effects of delivering support through different policy measures, using the **Policy Evaluation Matrix (PEM)**. The PEM model is a partial equilibrium displacement model developed by the OECD in co-operation with some Member countries. It has a direct link with the classification of agricultural support measures (the PSEs), and therefore covers only stylised versions of the measures currently in place. [The main results found so far point in the direction that different support measures have differentiated impacts on trade and farm income. Particularly, that price support and payments based on output or input have larger impacts on trade and less income transfer efficiency than payments based on area.]

The OECD prepares and publishes an annual Agricultural Outlook report, giving 5-year projections for the major agricultural commodities, using **AGLINK**. AGLINK is a partial equilibrium model for the supply, consumption and prices of the main OECD agricultural commodity markets (although sheepmeat and wool are largely exogenous). The model consists of complete modules for ten OECD countries/regions (Australia, Canada, European Union (15), Hungary, Japan, Korea, Mexico, New Zealand, Poland, and the United States) and three non-OECD countries/regions (Argentina, China and the Rest of the World). The rest of the OECD and the former USSR are considered exogenous to AGLINK. The AGLINK projections are also used as a yardstick to measure the market and trade impacts of emerging domestic and trade policy developments. The fully documented database, including historical data, projections and selected scenarios is available on CD-ROM.

OECD also houses the **Agricultural Market Access Database** or AMAD (www.amad.org). This database is the product of a co-operative effort between the OECD and other international organisations and national agencies and was updated in 2001.

Over the past ten years considerable effort has gone in to developing a set of **agri-environmental indicators**, details of which can be found on the OECD agri-environmental indicator website (http://www.oecd.org/agr/env/indicators.htm).

Work is also underway on an **inventory of measures for the environment in agriculture**, which will include economic instruments (subsidies or payments, taxes or charges), regulatory measures, and voluntary co-operative approaches. The inventory, to be completed this year, will help evaluate policies and recommendations on the best mixes of policies and market approaches to ensure the least trade-distorting sustainable agriculture.

New Zealanders and OECD Agriculture

New Zealand has had a close and fruitful involvement with the work of the Agriculture Directorate over the years.

Various New Zealanders have been employed in the Secretariat, most notably Professor Bruce Ross in the 1980s to develop the MTM model (Ministerial Trade Mandate) which quantified the trade impacts of agricultural assistance programmes in Member countries. This analysis underpinned the 1987 OECD Ministerial Principles for Agricultural Policy Reform, which in turn provided a basis of understanding and a set of guidelines for the subsequent GATT Uruguay Round agriculture negotiations.

Other New Zealanders have spent varying amounts of time in the Directorate, some later returning to use their experience in trade policy work in MAF.

New Zealanders have on several occasions been elected to the Chair of OECD agriculture bodies, most notably Professor Ross as Chair of the Committee for Agriculture from 1998-2001. Others have taken Chair or Vice-Chair positions on various of the subsidiary bodies of the Committee for Agriculture.

Workshops, expert meetings and conferences have provided the opportunity for New Zealand agricultural economists, academics and scientists, and farmer and industry representatives to participate in specialised topic areas of the work programme. Some of this involvement has later led to consultancy work with the Directorate. For example, Professor Anton Meister, Massey University has been used in the programme of work related to multifunctionality of agriculture. For others, access to OECD 'work in progress' has allowed them to make an input into the work, or on the other hand to establish links with the OECD staff in such a way as to inform the development of their own particular research or analytical work.

In preparing for OECD agriculture meetings, officials often consult with academics, industry groups and other government departments for gathering information or forming a view of what new Zealand's best interests are and how to present them. Industry groups, regional councils and others also provide information from time to time which is sought by the Secretariat to enhance their database and progress their analytical work.

Annex 1

OECD Member Countries

Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

Annex 2

STRUCTURE OF THE OECD SECRETARIAT

General Secretariat		
Economics Department	Statistics Directorate	Environment Directorate
Development Co-operation Directorate	Public Management Service	Trade Directorate
Directorate for Financial, Fiscal and Enterprises Affairs	Directorate for Science, Technology and Industry	Directorate for Education, and Employment, Labour and Social Affairs
Directorate for Food, Agriculture and Fisheries	Territorial Development Service	Directorate for Public Affairs and Communications

SEMI-AUTONOMOUS BODIES

Nuclear Energy Agency	Development Centre	Centre for Educational Research and Innovation
International Energy Agency	European Conference of Ministers of Transport	Sahel and West Africa Club

Annex 3

Shared goals for the agro-food sector

OECD Agriculture Ministers in March 1998 assessed the progress in the reform of agricultural policy and gave indications for future directions. Building on principles agreed by OECD Ministers in 1987, OECD Ministers adopted a set of shared goals that should ensure that the agro-food sector:

- is responsive to market signals;
- is efficient, sustainable, viable and innovative, so as to provide opportunities to improve standards of living for producers:
- is further integrated into the multilateral trading system;
- provides consumers with access to adequate and reliable supplies of food, which meets their concerns, in particular regard to safety and quality;
- contributes to the socio-economic development of rural areas; and
- contributes to food security at the national and global levels.

Ministers agreed that policy measures should seek to meet operational criteria in both the domestic and the international contexts. Policies should be:

Transparent with identifiable policy objectives, costs, benefits and beneficiaries;

Targeted to specific outcomes, and as far as possible decoupled;

Tailored to provide transfers just sufficient to achieve identifiable outcomes;

Flexible to reflect the diversity of agricultural situations, to be able to respond to changing objectives and priorities and to be applicable to the time period needed for the specific outcome to be achieved; and

Equitable in taking into account the effects of the distribution of support between sectors, farmers and regions.

Annex 4
OECD Committee for Agriculture

WORK PROGRAMME

- **Monitoring** and Evaluation of Agricultural Policy Developments

  -- including Policy Evaluation Matrix (PEM)

- Medium Term **Outlook** and related policy issues

  -- Aglink

- Agricultural **Trade** and other Transboundary Issues

  -- Domestic/trade policy interface
  reinstrumentation (PEM analysis)
  food safety, animal welfare, labels of origin
  biotechnology
  food security
  (multifunctionality)
  trade liberalisation/environment linkages

  -- Trade aspects of competition and market structure
  state trading
  export restrictions and taxes
  export subsidies and export credits
  price pooling and price discrimination

  -- Evaluating and strengthening trade liberalisation
  evaluating impacts of UR (protection, TRQs)
  analysis of further liberalisation

- Policy approaches and instruments to address **Multifunctionality** and to facilitate **Structural Adjustment**

  -- Multifunctionality
  Workshop held July 2001 to examine empirical studies

  -- Structural adjustment
  farm household labour (incl PEM analysis)
  distribution of agricultural support
  market concentration

  -- Farm household income
  low incomes in agriculture
  income risk management (2000 Workshop)

  -- Direct payments
  conceptual work on decoupling

- **Environmentally** Sustainable Agriculture in OECD Countries

  -- Agri-environmental indicators

  -- Agri-environmental policy analysis
  principles and criteria for policies
  classification of agri-environmental measures
  sustainable agriculture

  -- Water issues

  -- Workshops (Sustainable Farming Systems, July 2000)
  (Organic Farming, Sept 2002)

- Agricultural Policies in **non-Member** Countries

  -- Annual policies report

  -- Country reviews

  -- Recent developments in non-Member countries

- **Food Safety**

- **Other Activities**

  Codes and Schemes: Fruit and vegetable standards
  Seeds
  Forest reproductive material (not NZ)
  Tractor testing standards (not NZ)

  Co-operative Research Programme (Biological resource management for sustainable agricultural systems)

  Conference on Agricultural Knowledge Systems (AKS) addressing food safety and environmental issues (January 2000)

THE IMPACTS OF TRADE LIBERALISATION ON THE WORLD RICE MARKET

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ABSTRACT

Rice is the most important basic staple food for about one-half of the world's population and provides over 20 percent of the global calorie intake (FAO,2000). As a result of increases in population and economic growth, rice consumption has increased faster than production, resulting in increases in price of rice in the world market over the last decade. Asia is responsible for slightly less than 90 percent of global rice production and consumption, about 50 percent of imports, and 72 percent of exports (FAO,2000).

Although rice is widely grown and consumed, less than 6 percent of world production is traded annually compared with about 18 percent for wheat, 25 percent for soybeans, and almost 13 percent for corn (USDA, 2001). The rice market is "thin" or "residual" in the sense that the ratio of exports to production is smaller than for other grains (USDA, 2001). One of the main reasons for this small ratio of trade to production is the trade barriers in both developed and developing countries. Cramer, Wailes, and Shui (1993) identified import quantity restrictions, import tariffs, and customs taxes are the major import barriers and deficiency payments, input subsidies, currency overvaluation as indirect trade distortion policies on world rice trade.

The high level of intervention in rice trade clearly has significant impact on consumption, production and welfare. Therefore the Lincoln Trade and Environmental model (LTEM) is used to examine the impact of rice trade liberalisation on the selected countries under four different policy scenarios. The policies specified are full liberalisation in all the countries in the model; liberalisation of developed countries (Australia, EU (15), Japan and US); the Uruguay Round Agricultural Agreement; and the liberalisation of Japan and South Korea.

The results from analysis suggest that total welfare is predicted to increase in all the importing countries such as Bangladesh, Brazil, EU (15), Indonesia, Japan and South Korea under all policy scenarios. However, total welfare is predicted to decrease in the exporting countries such as Australia, India, Pakistan, Thailand, United States and Vietnam under the liberalisation of developed countries and liberalisation in Japan and South Korea. Total welfare is predicted to decrease in Australia, Pakistan, United States and is predicted to increase in India, Thailand, Vietnam under full liberalisation and the URAA.

The model predicted a net total welfare gain under all policy scenarios. Full liberalisation in all the countries in the model predicted the highest net welfare gain of

$ US 40.5 billion. Developing countries as a group would benefit more than the developed countries under this scenario.

Liberalisation in Japan and South Korea predicted the second highest net welfare gain of $ US 20.3 billion. All the importing countries in the model are predicted to gain while all the exporting countries are predicted to lose under this scenario. Japan and South Korea is predicted to gain by the withdrawal of the government intervention in rice industry in these countries.

The predicted total net welfare gain under liberalisation of developed countries is $ US 13.6 billion and it is experienced almost exclusively by the developed countries. Thus, impact on developing countries under this scenario is negligible. This is not surprising, however, given that in most developed countries rice is only a marginal food, while in developing countries it is a major staple food. Furthermore the results indicate that the effect on the world rice market with liberalisation of rice policies in South Korea is higher than the cumulative effect of developed countries such as US, EU (15) and Australia.

The total net welfare effect of the URAA is predicted to be insignificant.

Key words: Rice trade, trade restrictions, trade liberalisation, total welfare, net total welfare and developing countries

1 INTRODUCTION

Rice is the most important basic staple food for about one-half of the world's population and provides over 20 percent of the global calorie intake (FAO,2000). Asia is responsible for nearly 90 percent of global rice production and consumption, about 50 percent of imports, and 72 percent of exports (FAO,2000). Although rice is widely grown and consumed, less than 5 percent of world production is traded annually compared to about 18 percent for wheat, 25 percent for soybeans, and almost 13 percent for corn (USDA, 2001). Even though trade liberalisation under the Uruguay Round Agreement of the World Trade Organisation (WTO) and other trade agreements such as NAFTA[1] and MERCOSUR[2] have contributed to the increase in world rice trade since 1994, rice continues to be one of the most highly protected agricultural commodities with tariff rates ranging from 50 percent to 230 percent in 2000 (Cramer, Hansen and Wailes, 1999). Protectionist policies for rice include support prices, which are maintained by associated policy measures such as quantitative restrictions on production and imports; taxes, levies and tariffs on imports; export subsidies; and public stockholding. The most common policies to protect the domestic producer are input subsidies, minimum support prices, tariff and non-tariff barriers (eg. quota). Even though producers are protected by tariffs and other support policies, to off-set the impact on consumers, most developing countries also provide consumer subsidies. Countries benefit from trade liberalisation through more efficient allocation of resources among economic activities, through changes in terms of trade, or in prices obtainable for exports relative to those for imports. This is especially important in the case of rice, as many rice producing and consuming countries are poor developing countries in Asia.

Therefore the objectives of this study is to identify the rice trade policies of selected countries; estimate the effects of changes in trade policies on exports, imports, production and consumption; and to quantify the welfare effects of these policies. The countries selected in this study are Australia, Bangladesh, Brazil, China, European Union (15), India, Indonesia, Japan, Pakistan, South Korea, Thailand, United States and Vietnam. Section one introduces the problem to be addressed, the objectives of the study .Section two sets out detailed background on the world rice trade and current domestic support and trade policies prevailing in major exporting and importing countries in the world. Section three discuses the chosen modelling approach. Development of a specific rice trade model and a policy simulation procedure are discussed in section four. Data requirements and sources of data are also identified, as well as the evaluation of the effects on exports, imports, production and consumption of rice, and the welfare gain/loss for selected countries as a result of potential policy changes in the rice sector. Section five provides a summary of the major findings and conclusions of the study and hence recommendations for further research.

The world rice trade increased from 12 million metric tonnes in 1990 to 23 million metric tonnes in 2000, an increase of 92 percent. Trade is projected to increase further by about 2 percent per annum to 24 million tonnes by 2005 (or 6 percent of the projected world production) (FAO, 2000). The global rice export market is concentrated. Thailand was the largest exporter (around 25 percent of global trade) over the last decade. Vietnam ranked second (around 17 percent) and the United States held third position (around 12 percent) (USDA, 2001). China, India, and Pakistan were also major exporters. The import market is far less concentrated. Indonesia, Brazil, Iran, Bangladesh, Nigeria, and the Philippines are typically the largest importers, together importing 25-40 percent (USDA, 2001). Other large importers include the EU, Saudi Arabia, Iraq, Malaysia, Senegal, South Africa and Japan.

The rice policies of selected countries

The governments of Australia, China, the European Union, Indonesia, Japan, South Korea and the United States protect rice producers with producer market subsidies whilst the governments of Bangladesh, Brazil, India, Thailand and Vietnam taxed the producers. The consumers of Bangladesh, Brazil, India, Thailand, The United States and Vietnam are provided consumer subsidies whilst the consumers of Australia, China, the European Union, Indonesia, Japan and South Korea are taxed. The pricing and marketing of rice in Japan and South Korea are subject to a high degree of government intervention. In fact the government has a monopoly in the rice market in these countries. As a result of URAA, Japan and South Korea were pressured to liberalise their rice market. However the Pakistan government does not intervene in the rice market. Access to the Australian rice market is relatively free, with limited government intervention.

3 PARTIAL EQUILIBRIUM TRADE MODELS

Partial equilibrium trade models focus on international markets for a selected set of traded goods, such as agricultural goods. In most cases, they consider the agricultural system as a closed system without linkages to the rest of the economy. Effects of the rest of the domestic and world economy on the agricultural system could be included by altering parameters and exogenous variables. The models may be single or multi-product. Multi-product models are able to capture supply and demand interrelationships among different products. Most partial equilibrium trade models include either linear or log linear behavioural equations, which allow the representation of supply and demand relationships prevailing in the market under study. They also incorporate exogenous variables such as technical change, population and household income into their supply and demand relationships.

Partial equilibrium trade models have primarily been constructed to provide insight into the implications for domestic and international agricultural markets of existing and alternative agricultural policies. The models generate information on the effects of such policies on domestic supply, demand and prices, the volume of international trade and "world market" prices. This information is often used to compute partial equilibrium welfare measures such as producers' and consumers' surplus. An important characteristic of these models is their ability to capture the price effects of policy changes across related commodities, through substitution in supply and demand, and among countries through trade linkages. The models typically do not analyse the effects of policies on trade flows between individual countries, but on

[1] North American Free Trade Agreement: A trilateral agreement on trade, including agricultural trade among Canada, Mexico and the United States to phase out tariffs and revise other trade rules over a 15 year period. The agreement was signed in December 1992 and came into effect on 1 January 1994.
[2] MERCOSUR: A multilateral agreement on trade including agricultural trade among Argentina, Brazil, Paraguay and Uruguay. The agreement was signed in 1991 and came into effect on 1 January 1995. Its main goal is to create a custom union between the four countries by 2006.

aggregate net imports or exports. The information which different models provides on these factors is determined largely by their structure[3] and the way in which agricultural policies are incorporated (Blandford, 1990).

The models typically treat commodities as homogeneous. This simplification implies that only the behaviour of net trade can be analysed, even though many countries have both imports and exports of a commodity group and imports from different suppliers may not be perfect substitutes. An empirical evaluation of variations in such imports and exports is only possible if commodities are treated as imperfect substitutes. Interrelationships between commodities are reflected by cross-price elasticities, but these do not always meet theoretical restrictions, such as symmetry and homogeneity (Blandford, 1990).

Many models are static with "medium-term" elasticities. Only a few are dynamic. Therefore models provide limited information on stability. Furthermore they cannot determine the time path of the effects of changes in policy or evaluate the phasing of policy reform. The phasing of policy change and the implications of alternative policies for domestic and international market stability are important issues for both developed and developing countries.

Organisations or/and researchers have developed several multi-country multi-commodity partial equilibrium trade models for the purpose of trade analysis. Incidentally rice is a commodity found in many of these models. Some of the world wide used multi-country multi-commodity partial equilibrium trade models are AGLINK and MTM of OECD, GLS model of Tyers and Anderson (1986), Valdes and Zietz, (1980), ESIM and SWOPSIM of USDA/ERS (Tangerman and Josling, 1994; Roningen,1986; Roningen et al., 1990; Roningen and Dixit, 1986), FAO commodity model of FAO (FAO, 1993,1994,1998), FAPRI model of FAPRI (Devadoss et al., 1989), GAP model of Federal Agricultural Research Centre in Germany (Frenz and Manegold, 1988), MISS of Institut National de Recherche Agronomique (INRA) in France (Mahe and Moreddu, 1987).

Liefert , Koopman and Cook (1993) used a PE model to examine the effect of reform and trade liberalisation by the Republics of the former Soviet Union on their agricultural production, consumption and trade. Based on the PE models, Othman, Jani and Alias (1998) discussed the potential adjustments that would occur in the world palm oil market when Malaysia and Indonesia liberalised domestic protectionism and introduced trade enhancement measures in vegetable oils under the WTO rules. Moreover, Ballenger (1988), Cochrane (1990a, b), Dixit and Roningen (1986), Dixit , Herlihy and Magirra (1989), Gardiner, Roningen and Lui (1989), Gindel and Krissoff (1987) described applications which are relevant to the EU to Eastern Europe. Kissoff, Sullivan and Wainio (1990) adapted a PE model to examine how the agricultural sectors of developing countries might be affected by an ending of government intervention in agriculture in OECD countries. The study of Mabbs-Zeno and Krissof (1990) used a PE model to examine how government policies affected the global distribution of tropical beverage production, processing and trade. Roningen, Sullivan and Wainio (1987), Roningen and Dixit (1990) and Anderson and Tyers

[3] Major structural differences between models are in four areas: a) commodity coverage; b) country coverage c) temporal properties; and d) the "partiality" of their partial equilibria

(1990) also used a partial equilibrium model in agricultural trade liberalisation analysis.

The Lincoln Trade and Environmental Model (LTEM) which is based on the VORSIM shell (Roningen, 1996) will be used to evaluate the rice trade in the present study. VORSIM is a modern framework that is simple, and easy to manage as it operates in Excel Spreadsheets within the Microsoft Windows environment on personal computers. This model provides information and data on 18 countries and 18 commodities including rice. Moreover, the VORSIM framework is very flexible and can be managed to generate alternative for policy scenarios by changing the values of the exogenous variables.

This study will modify the LTEM model to include selected countries and the rice trade policies in simulation in order to evaluate the impact of rice trade liberalisation on the social welfare of these countries.

4 DATA AND ANALYSIS

4.1 Rice trade model

The model will consider thirteen major rice producing and consuming countries: Australia, Bangladesh, Brazil, China, European Union (15), India, Indonesia, Japan, Pakistan, South Korea, Thailand, United States and Vietnam to carry out the analysis.

The assumptions of the rice trade model are:

- A competitive world rice market
- Rice is a homogenous product (for example no distinction is made between Japonica rice and Indica rice). Furthermore domestic and imported rice are perfect substitutes.
- Technology is held constant
- Economic agents are risk neutral, and
- No uncertainty exists

Based on these assumptions the rice trade model is developed from the LTEM using the VORSIM nomenclature (Roningen, 1996) for the selected countries as follows:

XqpRI = XqpRI (XppRI, XppWH)
XqcRI = XqcRI (XpcRI, XpcWH, POP/GDP)
XqtRI = XqtRI (XqpRI-XqcRI)[4]

The VORSIM nomenclature and the model equations of all the countries for the base scenario are shown in Appendices A and B respectively.

The quantity of rice produced is a function of the producer price of rice and the prices of substitute commodities. For example wheat. The quantity of rice consumed in turn is a function of the consumer price, the prices of substitute commodities, for example wheat, and income per capita.

Once the model was constructed, it was initialised to a base year (year 2000) and equation intercepts were calculated which fitted each equation to the base year

[4] Where qp= quantity produced, qc= quantity consumed, qt= quantity traded, pp= producer price, pc= consumer price, X= sub country, RI= rice, WH= wheat, POP= population of X, GDP= Gross Domestic Product.

parameters and data. A global model with no administered policy change was then assembled so that the global trade for each product was balanced. Changes in policies were introduced into the model through changing variables. This caused disequilibrium in the model, which resulted in recalculation creating a new price quantity balance where world markets for rice and wheat were again cleared. The new equilibrium state was compared to the base state to determine the impact of the exogenous shock, and several types of indicators such as producer price, consumer price, trade price, quantity produced, quantity consumed, quantity net trade and welfare changes were calculated through this comparison of states. Thus, indicator variable values from the base and liberalised solutions were compared to determine differences from the base levels. The change in producer and consumer surpluses were computed from solution values to assess the welfare implications of policy changes.

Marshallian demand curves and partial equilibrium supply curves were used to compute the change in producer's and consumer's surpluses using year 2013 quantities and prices from the base and liberalised solution values. Although the Hicksian measures of economic surplus such as compensating variation (CV) and equivalent variation (EV) are more theoretically accepted measures, calculating the Hicksian measures of surplus from Marshallian demand curves would require additional information on the income elasticity of demand, the proportion of income spent on rice, or specification of an utility function (Varian, 1999). Since compensated demand curves are extremely difficult to estimate empirically, Marshallian demand curves were used to compute welfare, assuming that the income effect for rice was zero or negligible, the proportionate spending on rice was small, and producers and consumers were risk-neutral.

4.2 Data

The LTEM modelling framework allows the researcher to choose the model structure, define model product and regional coverage, and to specify the equations (Roningen, 1997). The following data for rice was required for each country being considered to develop the base scenario:

- Producer, Consumer and trade price ($ US/t)
- Production, Consumption, net trade and ending stocks (000' t)
- Policies: Producer and consumer subsidies or taxes, tariffs and quotas ($ US/t)
- Supply, Demand and Income elasticities.
- Macroeconomic data such as supply growth rates, Gross Domestic Product growth rates, population and its growth rate.

4.3 Sources of Data (Year 2000)

Data on rice trade were difficult to obtain, especially for developing countries. Ideally data should be from a single source to maintain consistency. However there was no single database that provided all relevant data for all the countries. Therefore, a series of databases were used and these included: Oryza market reports (www.Oryza.com), FAO statistical database (www.FAO.org), OECD Agricultural Commodities Outlook database 1970-2006, Rice outlook 2001 database of USDA (www.ers.USDA.gov), FAPRI 2001 Agricultural Outlook database (www.fapri.org), European Commission Agricultural database (europa.eu.int/comm/agriculture) and from individual country databases such as Department of Agriculture and Cooperation of India statistical database (AGRICO) and Department of Agriculture and Forestry of South Korea. (Base data is shown in appendix C)

The monetary values of any producer market supports or taxes were not available for all the countries even though information on the types of support or tax was available. Thus, quantification of policies was difficult. In order to maintain consistency Producer supports or taxes on rice were estimated using the difference between producer price and the trade price for all the countries. The difference between those prices was assumed to reflect the policy in a particular country. Thus, policy measures create a gap between the domestic producer price and the trade price of rice (A limitation of this method is that producer supports or taxes may be overestimated due to other reasons such as marketing and transport costs).

The producer price is a function of the trade price and policies such as producer subsidies, separated into market support, direct fees/levies and other. Therefore the total producer subsidies or taxes were estimated using the following equation.

$$sm_t^n = pp_t^n - pt_t^n \qquad (4.1)$$

where,

sm_t = total producer subsidy or tax at a given time t
pp_t = producer price at a given time t
pt_t = trade price at a given time t
t = time
n = country

When the trade prices of countries were compared, there were large discrepancies especially among Japan, South Korea and EU (15) as mentioned above. The reason for these discrepancies is assumed to be due largely to non-tariff barriers. Therefore as objective of this study is to examine the impact of trade liberalisation, the opportunity cost of rice in world price (Thai 100% Grade B) was used as trade prices (import prices) of those countries.

Similarly, quantification of consumer supports or taxes was difficult due to the unavailability of the monetary values of these policies. Therefore, consumer market supports or taxes were estimated using the difference between the consumer price and the trade price.

Consumer price is a function of the traded price and policies such as consumer market subsidies and other. Therefore total consumer market supports or taxes were estimated using the following equation.

$$cm_t^n = pt_t^n - pc_t^n \qquad (4.2)$$

where,

cm_t = total consumer subsidy at a given time t
pc_t = consumer price at a given time t
pt_t = trade price at a given time t
t = time
n = country

The estimated producer and consumer supports or/and taxes were checked against the actual policies where information is available. Thus, there was a small difference between the estimated policies and the actual values for Australia, Bangladesh, China, EU (15), India and US.

The elasticity parameters are key variables in the model since they determine the responsiveness of domestic supply and demand to changing prices and policy measures. Data were obtained from the study by Cramer et al. (1993) and 1997 OECD Database (Appendix D).

Macroeconomic data for each country such as growth rate of supply, growth rate of Gross Domestic Product, population and its growth rate were collected from the FAO statistical database.

4.4 Policy Scenarios

This section evaluates various policy scenarios and compares these results to the results of the base scenario. The LTEM was initially run with existing policies for the base year 2000) with iterations to the year 2013.

Four policy scenarios were run; full liberalisation, liberalisation in developed countries in the model (Australia, EU (15), Japan and US), repeat of the Uruguay Round Agriculture Agreement, and liberalisation of Japan and South Korea.

Scenario 1 Full liberalisation in all the countries in the rice model

The purpose of this scenario was to evaluate the impact on prices, production, consumption, trade and welfare of complete liberalisation of rice policies in both developed and developing countries in the model. Full liberalisation in both developed and developing countries in the model in theory was expected to increase welfare by much more than partial liberalisation in those countries.

The prior expectations were that the producer price in Australia, China, EU (15), Indonesia, Japan and South Korea to fall with the complete removal of producer market supports. Thus rice production in these countries was expected to fall. However, the producer price in Bangladesh, Brazil, India, Thailand and Vietnam was expected to rise with complete removal of producer taxes. Thus rice production in those countries was expected to rise.

Similarly the consumer price in Australia, China, EU (15), Indonesia, Japan and South Korea was expected to fall with complete removal of consumer taxes. Thus rice consumption in those countries was expected to rise. However, the consumer price in Bangladesh, Brazil, India, Thailand, United States and Vietnam was expected to rise with complete removal of consumer market supports. Thus rice consumption in those countries was expected to fall.

The responsiveness of production and consumption to changes in prices was expected to depend on the supply and demand coefficients (own and cross-price) of each country.

The world price was expected to rise with the trade liberalisation.

Scenario 2 Liberalisation of developed countries such as Australia, EU (15), Japan and United States of America

Interventions and distortions to agricultural markets are generally far more extensive in developed countries than in developing countries, with a supported market price being the principal means of providing agricultural assistance in developed countries (Tyers and Anderson, 1992). In 1997, market support constituted 62 percent of OECD agricultural support, compared with 23 percent for direct payments (OECD secretariat, 1998). Market support policies for producers increase production, reduce domestic consumption, restrict imports and encourage exports. It is also argued that developed countries' policies have a negative effect on developing countries' welfare.

Therefore the purpose of this scenario was to evaluate the impact on prices, production, consumption, trade and welfare on developed and developing countries in the model, of liberalising rice policies in developed countries in the model such as Australia, European Union, Japan and United States.

Prior expectations were that the producer price in all developed countries in the model was expected to fall with complete removal of producer market supports. Thus, rice production in those countries was expected to fall. The consumer prices in Australia, EU (15) and Japan were expected to fall with complete removal of consumer taxes. Thus, rice consumption in these countries was expected to rise. However, the consumer price in the US was expected to rise with complete removal of consumer supports. The world price of rice was expected to rise.

The producer and consumer prices of rice in developing countries in the model were expected to rise due to the rise in the world price. However, the percentage change in producer and consumer prices under liberalisation of developed countries was expected to be lower than under full liberalisation of both developed and developing countries in the model.

Scenario 3 A 36 percent cut in market supports by developed countries (Australia, EU (15), Japan and United States of America) and a 24 percent cut in market supports by developing countries (Bangladesh, Brazil, China, India, Indonesia, Pakistan, South Korea, Thailand and Vietnam).

In the URAA, developing countries were treated differently from the developed countries through what was termed special and differential treatment. This involved reductions in bound (maximum) tariff equivalents of two-thirds of those agreed by developed countries and an implementation period of ten years as opposed to six for developed countries.

This scenario models the impact of further reductions in support levels representing new agreements similar to those in the URAA. Thus, all rice market supports were cut in developed countries by 36 percent over six years and in developing countries by 24 percent over ten years. In most instances, market price support is provided by systems

of internal price support over and above tariffs, with internal support prices, export subsidies and tariff-quotas as major features.

Prior expectations were that the producer price in Australia, China, EU (15), Indonesia, Japan and South Korea was expected to fall in conjunction with reductions in producer market supports. Thus, rice production in those countries was expected to fall. However, the producer price in Bangladesh, Brazil, India, Thailand and Vietnam was expected to rise in conjunction with reductions in producer taxes. Thus rice production in those countries was expected to rise.

The consumer price in Australia, China, EU (15), Indonesia, Japan and South Korea was expected to fall in conjunction with reductions in consumer taxes. Thus rice consumption in those countries was expected to rise. However, the consumer price in Bangladesh, Brazil, India, Thailand, United States and Vietnam was expected to rise in conjunction with reductions in consumer market subsidies. Thus rice consumption in those countries was expected to fall. The world price was expected to rise in conjunction with reductions in market interventions.

Scenario 4 Full Liberalisation in Japan and South Korea.

Rice growing is by far the largest activity in Japanese and Korean agriculture and the levels of support for rice production in those countries are the highest in the world as discussed in section 2.2.2.

Therefore this scenario is based on a complete liberalisation of rice policies in Japan and South Korea while other countries maintain their current trade policies. The purpose of this scenario is to evaluate the impact on the world rice market and the rice market in these two countries of an extreme trade policy option, that is a complete import liberalisation.

Prior expectations were that the producer and consumer prices in Japan and South Korea were expected to fall with the complete removal of producer market supports and consumer taxes. Thus, rice production was expected to fall and rice consumption was expected to rise in both countries.

Furthermore the world price of rice was expected to rise, and the producer and consumer prices of rice in all the other countries were expected to rise due to the rise in the world price.

4.6 Evaluation of Results

Results for each scenario are predicted for the year 2013 and presented in tabular format. Production, consumption and trade values are summarised in Appendices J, K and L respectively.

Scenario 1 Full liberalisation of all the countries in the model

The results of this scenario are presented in Appendix E. These show that the model predicted about 1 percent decrease in trade prices for all the countries included in the model by year 2013 compared to no policy change. The direction was unexpected

because the effect of consumption supports is higher than the effect of producer supports in the model.

Results indicate that free trade would result a decrease in producer price by 7.5 percent in Australia as expected. As a result of the removal of producer supports, rice production is predicted to decrease by 5.6 percent compared to no policy change. Since Australia has high supply response, this change meets prior expectations. With no consumer taxes the consumer price is predicted to decrease by 8.5 percent and consumption is predicted to increase by 3.5 percent. Exports are predicted to decrease by 10 percent.

According to the model free trade would result in a 66.7 percent increase in the producer price and a 13.5 percent increase in production for Bangladesh. The supply response to the change in producer price is low given highly inelastic supply elasticity that is 0.2. The model also predicted a 16 percent increase in the consumer price and a decrease in consumption by 13 percent. As expected production response is lower than the consumption response to changes in prices in Bangladesh. Therefore, Bangladesh is predicted to be an exporter in year 2013, exporting 4,415 thousand metric tonnes of rice compared to 3,007 thousand metric tonnes of rice imports under no policy change. This is a decrease in imports of 246 percent compared to base year 2000.

As expected in Brazil the model predicted a 41.8 percent increase in the producer price and a 33.4 percent increase in production under free trade compared to no policy change. The predicted increase in the consumer price is 30 percent with no consumer subsidies and this resulted in a decrease in consumption of 12.4 percent. However, Brazil is predicted to be an exporter by the year 2013, exporting 3,757 thousand metric tonnes of rice compared to 428 thousand metric tonnes of rice imports under no policy change. Thus, imports are predicted to decrease by 978 percent. This is the largest predicted effect on trade among all countries in the model under this scenario.

Under free trade the model predicted a 30 percent decrease in both producer and consumer prices in China with no producer subsidies or consumer taxes. The resulting decrease in production and increase in consumption is 6 percent and 24.4 percent, respectively. However China is predicted to maintain its position as the world's largest producer and consumer of rice even under free trade (Appendix J and K). Imports are predicted to increase by 510 percent mainly due to the higher demand for rice as a result of low consumer price. Therefore, results indicate that China will be the largest single importer in the world by the year 2013, importing 57, 531 thousand metric tonnes of rice (Appendix L).

Compared to no policy change the model predicted a 49.5 percent decrease in producer price and a 15 percent decrease in production in the European Union (15) under free trade with no producer subsidies. The predicted decrease in the consumer price and the increase in consumption are 48 percent and 27 percent respectively with no consumer taxes. These changes result in a 369 percent increase in imports in the EU (15) under free trade by 2013.

For India, the model predicted a 126 percent increase in the producer price but only a 25 percent increase in production with no producer taxes due to very low supply

elasticity. The resulting level of production (134,736 thousand metric tonnes) is the highest among all policy scenarios (Appendix J). The predicted increase in the consumer price is 104 percent as a result of no consumer subsidies and resulted in an 85 percent decrease in consumption. This is the lowest predicted consumption level among all policy scenarios (Appendix K). Under free trade India is predicted to experience a 953 percent increase in exports, becoming the worlds' largest exporter by the year 2013, exporting 119,789 thousand metric tonnes (Appendix L).

Free trade is predicted to result in a 34 percent decrease in producer price and a 40.7 percent decrease in consumer price in Indonesia with no producer subsidies or consumer taxes. These changes are consistent with theoretical expectations. The predicted decrease in production and increase in consumption are 7 percent and 33 percent respectively. Indonesia is predicted to be the second largest single rice consumer in the world by the year 2013, consuming 54,940 thousand metric tonnes (Appendix K). Imports are predicted to increase by 536 percent mainly due to low consumer prices. Therefore, Indonesia is predicted to be the second largest single importer in the world by the year 2013, importing 19,392 thousand metric tonnes (Appendix L).

In the case of Japan the model predicted a 95 percent decrease in both producer and consumer prices with no producer subsidies or consumer taxes. Therefore net farm income of rice producers in Japan would be adversely affected since the majority of rice producers grow rice on a small scale. However, production is predicted to decrease by 47 percent while consumption is predicted to increase by 24 percent due to low responses in supply and demand to the changes in prices. Imports are predicted to increase by 479 percent, an increase in imports of 5,924 thousand metric tonnes (Appendix L).

There is no change in policies in Pakistan. However all prices in Pakistan are predicted to decrease by 1 percent due to policy changes in all the other countries reflecting change in the world price. There is no significant predicted response in production, consumption and exports of rice.

The removal of producer subsidies in South Korea is predicted to result in an 89 percent decrease in the producer price. A 45 percent decrease in production is predicted to follow from the price decrease as expected due to a low elasticity of supply. The predicted decrease in consumer price and increase in consumption is 91 percent and 32 percent respectively with no consumer taxes again as expected due to a low elasticity of demand. The model also predicted a 626 percent increase in imports (4,843 thousand metric tonnes) by the year 2013 (Appendix L). Thus, the removal of trade restrictions would increase imports in South Korea as expected.

For Thailand, the model predicted a 63 percent increase in both producer price and consumer price by the year 2013 under free trade. However there is a predicted 19 percent increase in production and 51 percent decrease in consumption. Exports are predicted to increase by 97 percent, an increase of 10,002 thousand metric tonnes compared to no policy change. Thailand is predicted to be the second largest exporter in the world by the year 2013, losing its position as the largest rice exporter to India (Appendix L).

In the case of the United States of America (USA), free trade predicted a 12 percent decrease in the producer price and a 5 percent decrease in production as expected due to low level of producer subsidies. The removal of consumer subsidies is predicted to increase the consumer price by 2 percent. However, the consumption is predicted to decline by only 1 percent. Exports are predicted to decrease by 9 percent and, the USA is predicted to slip from the worlds' fourth largest exporter to sixth place (Appendix L).

The model predicted a 55 percent increase in the producer price and an 8 percent increase in production in Vietnam with the removal of producer taxes. The supply response is low due to low supply elasticity that is 0.15. The consumer price is predicted to increase by 43 percent with no consumer subsidies, resulting in a 7 percent decline in consumption by the year 2013. Exports are predicted to increase by 39 percent (3,824 thousand metric tonnes) compared to no policy change. Vietnam is predicted to be the third largest exporter in the world by the year 2013 (Appendix L).

For countries in the rest of the world, the model predicted a decrease in producer price of about 1 percent and a decrease of production by 33 percent. The consumer price is predicted to decrease by less than 1 percent. However, consumption is predicted to increase by 37 percent whereas the imports are predicted to increase by 277 percent, which would amount to 78,888 thousand metric tonnes by year 2013. The production and the consumption responses are surprising due to low elasticities of supply and demand. However, in order to balance at the end, the model may be forced to predict large responses because of the low responses in many countries in the model.

Scenario 2 Liberalisation of developed countries

The results of this scenario are presented in Appendix F. Similar to scenario 1, the model predicted a 0.5 percent decrease in trade prices for all the countries by the year 2013, when compared to no policy change. Since predicted change is insignificant, the direction is unexpected.

In Australia, the liberalisation of developed countries in the model is predicted to decrease the producer price by 7 percent compared to no policy change. As a result, production decreases by 5 percent. The consumer price is predicted to decrease by 8 percent resulting in a 6 percent increase in consumption. Exports are predicted to decrease by 11 percent.

The model predicted a 49 percent decrease in producer price and a 15 percent decrease in production as expected in European Union (15) with developed country liberalisation. The predicted decrease in consumer price is 47.5 percent and as a result consumption increases by 26 percent compared to no policy change. Imports are predicted to increase by 364 percent by 2013, an increase of 860 thousand metric tonnes.

For Japan the model predicted a 94 percent decrease in both producer and consumer prices with developed country liberalisation, compared to no policy change. As a result, production is predicted to decrease by 47.5 percent while consumption is predicted to increase by 24 percent. Imports are predicted to increase by 477 percent, or 5,896 thousand metric tonnes (Appendix L).

In the United States of America (USA), the model predicted an 11 percent decrease in the producer price and as a result a 5 percent decrease in production with developed country liberalisation compared to no policy change. However, the predicted effect on consumer price and the level of consumption is very small. Exports are predicted to decrease by 8.5 percent, and the USA would maintain its position of being the world's fourth largest exporter by 2013 (Appendix L).

The predicted impact on producer price, consumer price, trade price, production and consumption of all developing countries in the model due to liberalisation of developed countries compared to no policy change is insignificant. Since rice is not a major staple food in developed countries, interventions in the rice market by the governments except in Japan is very low. However imports in Bangladesh, Brazil, China, Indonesia and South Korea are predicted to increase by 5.5 percent, 14.5 percent, 9.5 percent, 7.5 percent and 4 percent respectively. Exports from India, Pakistan, Thailand and Vietnam are predicted to decrease by 5 percent, 0.8 percent, 0.9 percent and 0.4 percent respectively.

Although the predicted changes in producer and consumer prices in countries in the rest of the world are insignificant under this scenario, production and consumption are predicted to increase by 9 percent and 14.5 percent respectively. Consequently imports are predicted to decrease by 44 percent. The change in imports is surprising given no significant change in price. However increase in production out steps increase in consumption.

SCENARIO 3 A 36 percent reduction in rice policies by developed countries and a 24 percent reduction in rice policies by developing countries

The results of this scenario are presented in Appendix G. Similar to scenarios 1 and 2, the model predicted a 1 percent decrease in trade prices for all the countries in the model by the year 2013 compared to no policy change.

For Australia, the model predicted that liberalisation in developed and developing countries under the import access commitments of the URAA would result in a decrease in the producer price of 3.4 percent, with a resulting decrease in production of 2.5 percent compared to no policy change. The consumer price is predicted to decrease by 3.7 percent resulting in a 1.5 percent increase in consumption under the policy change. Exports are predicted to decrease by 4.5 percent.

The model predicted a 15 percent increase in the producer price in Bangladesh, resulting in a 3 percent increase in production with a 24 percent reduction in producer taxes compared to no policy change. The impact of the URAA is lower than the impact of free trade as expected. The model further predicted a 3 percent increase in the consumer price and a 2.4 percent decrease in consumption. Imports are predicted to decrease by 51.5 percent by the year 2013.

The URAA predicted a 9.7 percent increase in the producer price and a 7 percent increase in production in Brazil compared to no policy change. The predicted increase in the consumer price is 6 percent and the predicted decrease in consumption is 2.6

percent. As a result of theses changes, Brazil is predicted to be an exporter by the year 2013, exporting 489 thousand metric tonnes of rice compared to 428 thousand metric tonnes of imports under no policy change. Thus Brazil is predicted to be an exporter under both the free trade and the URAA scenarios.

Compared to no policy change, the model predicted an 8 percent decrease in both the producer price and consumer price for this policy scenario in China. The predicted decrease in production and increase in consumption are predicted to be 1.6 percent and 6.5 percent respectively. However, China is predicted to maintain its position as the world's largest rice producer and consumer even after the policy changes (Appendices J and K). Imports are predicted to increase by 136 percent, due to the predicted decrease in the consumer price. Therefore China is predicted to be the largest single importer in the world by the year 2013, importing 22,230 thousand metric tonnes (Appendix L).

For the European Union (15), the model predicted an 18.5 percent decrease in the producer price and a 5.6 percent decrease in production after a 36 percent reduction in producer subsidies as expected. The predicted decrease in consumer price is 18 percent and the predicted increase in consumption is 10 percent. Overall, imports increase by 138 percent by the year 2013, an increase of 325 thousand metric tonnes compared to no policy change.

The impact of this policy scenario, which includes 24 percent reduction in producer taxes in India, is a 29 percent increase in the producer price and production is predicted to increase by 6 percent compared to no policy change. The predicted increase in consumer price is 24 percent and the decrease in consumption is 20 percent. As a result of these changes exports increase by 222 percent. India is predicted to be the world's largest rice exporter by year 2013, exporting 36,606 thousand metric tonnes of rice (Appendix L). Thus, India is predicted to benefit more compared to other countries in the model even under the URAA.

Under this scenario the model predicted a 9 percent decrease in the producer price and a 10.6 percent decrease in the consumer price in Indonesia. The resulting decrease in production and increase in consumption are 2 percent and 8.6 percent respectively. Results indicate that Indonesia would be the third largest single rice consumer in the world by the year 2013, consuming 44,778 thousand metric tonnes (Appendix K). Imports are predicted to increase by 139 percent mainly due to the low consumer price. Therefore Indonesia is predicted to be the second largest importer in the world by year 2013, importing 7,294 thousand metric tonnes (Appendix L).

For Japan, the model predicted a 35 percent decrease in both producer and consumer prices under the URAA. However, production is predicted to decrease by only 17.5 percent while consumption is predicted to increase by only 9 percent. Predicted imports increased by 176 percent, an increase of 2,177 thousand metric tonnes (Appendix L).

Even though there are no changes in policies in Pakistan, all prices are predicted to fall by 1 percent due to policy changes in the other countries in the market. There are no significant changes in predicted production, consumption or exports.

Results indicate that the URAA would cause a 22 percent decrease in both producer and consumer prices in South Korea. This results in a decrease in production of 11 percent and an increase in consumption of 8 percent, compared to no policy change. The predicted increase in imports is 156 percent, which would be 1,039 thousand metric tonnes by the year 2013.

According to the model, this policy regime would result in a 14 percent increase in both producer and consumer prices in Thailand by the year 2013. The resulting increase in production is 4 percent and the decrease in consumption is 12 percent. Exports are predicted to increase by 22 percent, an increase of 2,274 thousand metric tonnes compared to no policy change. Thailand is predicted to be the second largest exporter in the world by the year 2013 (Appendix L).

For the USA, the model predicted a 5 percent decrease in the producer price and as a result a 2 percent decrease in production, with a 36 percent reduction in producer subsidies compared to no policy change. However, there is no effect on the predicted consumer price and thus on the level of consumption. Overall exports decrease by 4 percent, but the USA would maintain its position as the world's fourth largest exporter by 2013 (Appendix L).

In Vietnam, the model predicted a 12 percent increase in the producer price and a 2 percent increase in production with a 24 percent reduction in producer taxes compared to no policy change. The consumer price is predicted to increase by 10 percent and as a result consumption decreases by 1.5 percent by the year 2013. Exports are predicted to increase by 8.7 percent, an increase of 857 thousand metric tonnes compared to no policy change. As a result, Vietnam is predicted to be the third largest exporter in the world by the year 2013 (Appendix L).

Compared to no policy change the model predicted a 1 percent decrease in the producer price in the countries in rest of the world. The predicted production decrease is about 7 percent under URAA compared to no policy change. The consumer price is predicted to decrease by less than 1 percent. However, consumption is predicted to increase by 28 percent, even though it is unexpected. Imports are predicted to increase by 48 percent, an increase of 9,991 thousand metric tonnes by year 2013.

SCENARIO 4 Full liberalisation in Japan and South Korea

The results of this scenario are presented in Appendix H. Similar to other scenarios, the model predicted a less than 1 percent decrease in trade prices for all the countries in the model by year 2013 compared to no policy change. The direction is unanticipated due to a very small change.

Full liberalisation in Japan and South Korea is predicted to reduce both producer and consumer prices by 95 percent in Japan. As a result production in Japan is predicted to decrease by 47.5 percent while consumption is predicted to increase by 32 percent by 2013. Imports are predicted to increase by 477 percent, or 5,901 thousand metric tonnes.

The South Korean producer price is predicted to decrease by 89 percent and result in a production decrease of about 45 percent. The consumer price is predicted to decrease

by 91 percent and as a result consumption is predicted to increase by 32 percent. Imports are predicted to increase by 623 percent, an increase of 4,157 thousand metric tonnes compared to no policy change.

The impact of this policy scenario on other countries in the model is insignificant, with a less than 1 percent decrease in the producer and consumer prices. Consequently, the predicted decrease in production is less than one percent. Consumption in United States is predicted to increase by 1.3 percent under full liberalisation in Japan and South Korea. However, consumption in all the other countries (except Japan, South Korea and United States) are predicted to increase by less than one percent.

The exports of Australia, Pakistan, United States and Vietnam are predicted to increase less than one percent due to liberalisation in Japan and South Korea. However Indian exports are predicted to decrease by 5.7 percent by 2013. Imports of Bangladesh, Brazil, China, European Union and Indonesia are predicted to increase by 6 percent, 17 percent, 11 percent, 4 percent and 9 percent respectively. Surprisingly, the imports of the countries in the rest of the world is predicted to decrease by 60 percent, for an insignificant decrease in the world price.

Impact on welfare of the various policy scenarios

This section evaluates the impact on welfare of policy scenarios presented in previous section. The results are summarised in Appendix I.

Welfare calculations for a policy change are important because they determine the losers and gainers, hence help in policy formulation. Marshallian demand curve and partial equilibrium supply curves were used to compute the change in producers and consumers surpluses using year 2013 quantities and prices from the base and liberalised solution values. The results indicate that the impact on consumer surplus and producer surplus due to trade liberalisation is consistent with expectations.

The governments are expected to gain with the removal of producer or/and consumer supports and are expected to lose with the removal of producer or/and consumer taxes. However the net gain or the loss for the governments depends on the magnitude of each policy. For example, in Australia there is a predicted net loss of $ US 1.1 million for the government as consumer taxes are higher than the producer subsidies. The total welfare change is computed in terms of changes in consumer surplus, producer surplus and net government gain/loss.

Free trade is predicted to increase consumer surplus in Australia, China, EU (15), Indonesia, Japan and South Korea due to the removal of consumer taxes. In turn, in Bangladesh, Brazil, India, Thailand, Vietnam and United States experience a decrease of consumer surplus by the year 2013 due to the removal of consumer supports under full liberalisation. Japan is predicted to gain the highest consumer welfare compared to other countries under this scenario, a gain of $ US 36 billion. South Korea, China and Indonesia are predicted to gain $ US 14 billion, $ US 15 billion and $ US 6.5 billion respectively. In Australia, China, EU (15), Indonesia, Japan, South Korea and the United States a decrease in producer surplus is predicted due to the removal of producer supports under full liberalisation. In turn, Bangladesh, Brazil, India, Thailand and Vietnam are predicted to experience an increase in producer surplus due

to the removal of producer taxes. India is predicted to gain the highest producer welfare compared to other countries under this scenario, a gain of $ US 18 billion. The governments of Australia, Bangladesh, Brazil, India, Indonesia, South Korea and Vietnam are predicted to lose while the governments of the EU (15), Japan and the US are expected to gain with full liberalisation. Total welfare is predicted to increase in all the countries except in Australia, Pakistan and the US. The model predicted total welfare gains of $ US 13 billion, $ US 10 billion and $ US 6 billion in Japan, India and South Korea respectively.

For the URAA policy scenario, the model predicted an increase in consumer surplus in Australia, China, the EU (15), Indonesia, Japan and South Korea due to the partial removal of consumer taxes. Japan, China and South Korea are predicted to experience an increase in consumer welfare of $ US 12 billion, $ US 4 billion and $ US 4 billion. In turn, in Bangladesh, Brazil, India, Thailand and Vietnam a decrease of consumer surplus is predicted by the year 2013 due to the partial removal of consumer supports. India is predicted to experience a decrease in consumer welfare of $ US 3 billion. Under the present scenario, producer surplus is predicted to decrease in Australia, China, the EU (15), Indonesia, Japan, South Korea and the United States due to the partial removal of producer supports. Producer surplus in Japan, South Korea and China is predicted to decrease by $ US 10 billion, $ US 2 billion and $ US 3.5 billion respectively. In turn, Bangladesh, Brazil, India, Thailand and Vietnam are predicted to experience an increase in producer surplus due to the 24 percent reduction in producer taxes. India is predicted to gain the highest producer welfare compared to other countries under this scenario, a gain of $ US 4 billion. The governments of Australia, Bangladesh, Brazil, India, Indonesia, South Korea and Vietnam are expected to lose while the governments of EU (15), Japan and US are expected to gain under URAA. The model predicted total welfare increase in all the countries except in Australia, Pakistan and the US. Japan is predicted to experience the highest increase in total welfare ($ US 2.5 billion).

Consumer surplus is predicted to increase in all the countries in the model except in the US under the liberalisation of developed countries. Japan is predicted to gain the highest consumer welfare of $ US 35 billion compared to other countries in the model. Producer surplus is predicted to decrease in every country in the model by the year 2013. Under this policy scenario, the reduction in producer is predicted to be particularly significant in Japan, where it declines by $ US 22 billion. The governments of the EU (15), Japan and the US are predicted to gain due to their rice trade liberalisation. However, the government of Australia is predicted to lose. All the importing countries such as Bangladesh, Brazil, China, EU (15), Indonesia, Japan and South Korea are predicted to benefit with an overall increase in total welfare. By contrast the exporting countries such as Australia, India, Pakistan, Thailand, US and Vietnam would be worse off due to liberalisation of developed countries.

Consumer welfare is predicted to increase in all the countries in the model under liberalisation of Japan and South Korea. Further consumers in Japan and South Korea are predicted to gain $ US 36 billion and $ US 14 billion respectively with the removal of consumer taxes since the consumers in these countries are paying for all the support that is provided to the rice industry through high support prices. Producer welfare is predicted to decrease in all the countries in the model under liberalisation of Japan and South Korea. The pricing and marketing of rice in Japan and South Korea

are subject to a high degree of government intervention. Therefore the removal of producer supports in Japan and South Korea would lead to a decrease of producer welfare by $ US 22 billion and $ US 7 billion respectively.

Net Welfare Effects

This section evaluates the net welfare gain/loss associated with each policy scenario. Results are summarised in Table 4.1.

The model predicted a net total welfare gain under all policy scenarios. However, the distribution of the gains is very different depending on the scenario under consideration. Full liberalisation in all the countries in the model resulted in the highest net welfare gain of $ US 40.5 billion. Developing countries are predicted to benefit more than developed countries in the model under this scenario, a 66.5 percent of the total welfare gain. This implies that developing countries as a group would achieve higher welfare gains by participating in the liberalisation process than they would by relying on liberalisation by developed countries only. Major gainers are Bangladesh, China, India, Indonesia, South Korea and Thailand.

Liberalisation in Japan and South Korea results in the second highest net welfare gain of $ US 20.3 million. Therefore, the overall results imply that the liberalisation of rice policies in Japan and South Korea is more important on world rice trade than either the URAA or the liberalisation of rice policies in developed countries. The net predicted welfare gain under liberalisation in Japan and South Korea is about 50 percent of the net welfare gain predicted under full liberalisation. Japan is predicted to obtain 67 percent of the total gain under this scenario. South Korea is predicted to gain $ US 6.7 billion or 25 percent of the total full liberalisation gains. Thus, net increase in total welfare is gained totally by Japan and South Korea with liberalisation of their policies.

Table 4.1: Net Welfare Effects ($ US billion)

Policy Scenario	Total Welfare	Developed Countries	Developing Countries
Free trade	40.5	13.6	26.9
Free trade in developed countries	13.6	13.5	0.04
URAA	6.2	2.5	3.7
Free trade in Japan and South Korea	20.3	13.6	6.7

The predicted total net welfare gain under liberalisation of developed countries is $ US 13.6 billion and it is experienced almost exclusively by the developed countries. Thus, predicted net welfare gain in developing countries under this same scenario is insignificant. However, the net welfare gain by developed countries under this scenario is lower compared to full liberalisation. This may be due to the effect of developing country liberalisation. Furthermore a comparison between liberalisation of developed countries and liberalisation in Japan and South Korea reveals that the net predicted welfare effect of liberalisation of rice policies in South Korea has more impact on the world rice trade than the cumulative effects of liberalisation of rice

policies in Australia, EU (15) and US. This is due to the fact that access to rice markets in Australia and US are relatively free with low government intervention.

The URAA is predicted to result in a net welfare gain of $ US 6.2 billion, the lowest gain among all policy scenarios. Therefore the impact of the URAA is not consistent with expectations. The model predicts that developing countries as a group would benefit more than developed countries if rice supports are removed by 36 percent in developed countries and 24 percent in developing countries (60 percent of the total net welfare gain). This implies that protection in developed countries has a negative welfare impact on developing countries. However importing developing countries would benefit while exporting countries would be worse off.

5 CONCLUSIONS

5.1 Conclusions

Results indicate that producer price and production in Australia, China, the European Union (15), Indonesia, Japan, South Korea and the United States would decrease under full and URAA liberalisation of producer supports. In general the results were consistent with the expectations. In the case of Japan the model predicted a 95 percent decrease in the producer price, but only a 47 percent decrease in production. For South Korea the model predicted a decrease in the producer price of 89 percent and resulting a 47 percent decrease in production. The supply responses in these countries are lower than expected due to low supply elasticities. All countries mentioned above predicted a decrease in domestic producer price resulting major reductions in net farm income. Thus producer welfare decreased in these countries. For example the producers of Japan and China would lose $ US 22 billion and $ US 12 billion respectively, under full liberalisation.

The producer price and rice production in Bangladesh, Brazil, India, Thailand, and Vietnam are predicted to increase by year 2013 under full and URAA liberalisation of producer market taxes compared to no policy change. For India, the model predicted a 126 percent increase in the producer price but only a 25 percent increase in production under free trade. According to the model free trade would result in a 66.7 percent increase in the producer price and a 13.5 percent increase in production for Bangladesh. Under this scenario the model predicted a 55 percent increase in the producer price and an 8 percent increase in production in Vietnam. The supply response to the change in producer price is low in these countries given the inelastic supply elasticities. Producer welfare is predicted to increase in these countries. For example, producers in India would gain $ US 18 billion, a 50 percent of producer income under full liberalisation.

The consumer price in Bangladesh Brazil, India, Thailand, the United States and Vietnam are predicted to increase with full and URAA liberalisation of consumer supports. Thus rice consumption in these countries is predicted to decrease. In the case of Japan the model predicted a 95 percent decrease in the consumer price and only a 24 percent increase in consumption. For South Korea the model predicted a decrease in the consumer price of 91 percent and resulting a 32 percent increase in consumption. The demand responses in these countries are low due to low demand elasticities. However, overall consumer welfare is predicted to decrease with the increase in the consumer price. The consumers in India, Bangladesh and Vietnam

would lose $ US 7.5 billion, $ US 1 billion and $ US 1 billion in welfare respectively under full liberalisation.

According to the results the consumer price in Australia, China, the European Union (15), Indonesia, Japan, and South Korea is predicted to decrease with full and URAA liberalisation of consumer taxes compared to no policy change by year 2013. Thus rice consumption and consumer welfare in these countries is predicted to increase. The consumers in Japan, South Korea, China and Indonesia would gain $ US 36 billion, $ US 13.8 billion, $ US 15 billion and 6.7 billion in welfare respectively under full liberalisation.

The high production and the consumption responses in rest of the world are surprising due to low elasticities of supply and demand. However, in order to balance at the end, the model may be forced to predict large responses because of the low responses in many countries in the model.

Even though the world price was expected to increase with the removal of rice policies, simulation results indicate that the price will actually decrease slightly under every scenario. This may be mainly due to the high consumer supports in the selected countries in the model.

The analyses suggest that Bangladesh and Brazil would become exporters by the year 2013 under the full liberalisation. Bangladesh would export 4,415 thousand metric tonnes of rice compared to 3,007 thousand metric tonnes of rice imports under no policy change. Therefore Bangladesh being one of the poorest countries in the world would gain economic benefits by exporting rice with full liberalisation. Brazil is also predicted to be an exporter, exporting 3,757 thousand metric tonnes of rice compared to 428 thousand metric tonnes of rice imports. These countries are predicted to experience an excess supply due to an increase in production and a decrease in consumption with full liberalisation by the year 2013.

China is predicted to maintain its position as the world's largest single rice producer, consumer and importer even under trade liberalisation, not surprising given its population growth. India is predicted to be the world's second largest single rice producer by the year 2013 followed by Indonesia and Vietnam under all scenarios. India is predicted to be the world's largest single exporter followed by Thailand and Vietnam under all scenarios. Indonesia is predicted to be the second largest importer under full liberalisation and URAA followed by Japan. Japan is predicted to be the second largest importer under liberalisation of developed countries and liberalisation of Japan and South Korea. South Korea is predicted to be the third largest importer under the liberalisation of Japan and South Korea.

The model predicted a net total welfare gain under all policy scenarios. Full liberalisation in all the countries in the model resulted in the highest net welfare gain of $ US 40.5 billion. However, it is relatively small compared to GNP (Gross National Product). Developing countries as a group are predicted to gain 66.5 percent of the net total welfare gain under this scenario. Thus, all developing countries in the model except Pakistan are predicted to benefit under this scenario. The impact on Pakistan is predicted to be negative but small in magnitude. India is predicted to benefit most under this scenario ($ US 10.5 billion) while the EU (15) experienced the smallest net

gain ($ US 0.1 billion). South Korea is predicted to gain $ US 6.7 billion under free trade. Therefore the analysis indicates that rice trade liberalisation would benefit developing countries more than the developed countries. However, if South Korea is classed as a developed country (OECD classification) the net gain by both developed and developing countries would almost be equal (about $ US 20 billion). Thus classification of South Korea changes the distribution of net total welfare for these two groups of countries.

Liberalisation in Japan and South Korea is predicted to result in the second highest net welfare gain of $ US 20.3 billion. Even though the effects are insignificant, all the importing countries in the model are predicted to gain while all the exporting countries are predicted to lose under this scenario. Developing countries are predicted to gain net welfare of $ US 6.7 billion and it is similar to the gain of South Korea. Thus gain by other developing countries in the model is insignificant. Similarly, developed countries are predicted to gain net welfare of $ US 13.6 billion and it is similar to the gain of Japan. Therefore, withdrawal of the government intervention the in rice industry in Japan and South Korea would increase welfare by a great amount in these countries, but have an insignificant impact elsewhere.

The predicted total net welfare gain under liberalisation of developed countries is $ US 13.6 million and most of this gain is in the developed countries. This is lower than the gain from liberalisation of Japan and South Korea under WTO is considered developing country. Thus, the impact on developing countries is not consistent with initial expectations under this scenario. This is not surprising, however, given that in most developed countries with possible exception of Japan rice is only a marginal food, while in developing countries it is a major staple food. In addition, Australia and the US have limited intervention in the rice industry. Furthermore the results indicate that the effect on the world rice market with liberalisation of rice policies in South Korea is higher than the cumulative effect of all developed countries except Japan such as US, EU (15) and Australia. In most cases, the impact of liberalisation of developed countries on developing countries is significant.

The URAA for rice includes 36 percent tariff reduction by developed countries over six years and 24 percent tariff reduction by developing countries over ten years. However, the overall total net welfare effect of the URAA is predicted to be insignificant. This may be because a 24 percent reduction in policies by developing countries would not have significant impact on welfare. However India and South Korea gained $ US 1.1 million and $ US 0.9 million respectively. Japan is predicted to gain the highest benefit of $ US 2.5 million under the URAA policy scenario.

5.2 Limitations

This study has some limitations. Although rice is widely grown and consumed in developing countries in Asia, there was no single updated global database for those countries. The available agricultural databases in many developing countries were sparse, incomplete and inconsistent and hence considered unreliable for estimation procedures. The study tried to maintain consistency by obtaining relevant data from various global data bases such as Oryza, FAO, OECD, USDA, FAPRI and EUROPA, rather than from the individual country databases.

Data on rice policies were also difficult to obtain. Moreover policies affecting rice are very complex. Therefore, producer and consumer supports or taxes on rice were estimated using the difference between the producer price or consumer price and the trade price for all the countries to maintain consistency. The difference between those prices was assumed to reflect the policy in a particular country. However this method may have overestimated the policy effect due to other transaction costs such as marketing and transport costs.

Another limitation was the lack of availability of recent demand and supply elasticities. Despite the demand and supply elasticities being outdated, the model was constructed with most recent available elasticities. However, the supply responses of Japan, South Korea, India and Bangladesh were very small. Ideally, elasticities should be estimated for each country using rice prices and quantities. However this would involve a considerable amount of additional research and was therefore considered to be beyond the scope of the present study.

Even though rice has two main varieties: short grain Japonica and long grain indica, the rice trade model assumed that rice was a homogenous commodity. Therefore model excluded the product differentiation. However the collection of the demand and supply data of different varieties would be difficult.

5.3 Suggestions for further research

Further research may include be the development of an improved dataset and revised parameter estimates especially for developing countries. The data system needs to be upgraded to collect, store and make readily available key data series, especially for prices, quantities and other policy information, for analysis purposes. This is an important task since it limits the type and scope of analysis, which can be undertaken in developing countries. However the outcome of policy analysis on the assumed values of model parameters can be examined with utilisation of systematic sensitivity analysis.

Another area for future research involves more explicit modelling of rice domestic and trade policies. Voluntary programs participation, quantitative restrictions and stock release rules are all common types of rice sector interventions which lend themselves to explicit treatment in modelling. Further this study would benefit with the examination of behavioural patterns in demand and supply of Japan and South Korea. Thus, model simulation with estimated demand and supply elasticites in these countries would help in analysis.

A general equilibrium model could be used to analyse the effect of changing policies on other sectors in the economy and on the labour market, which is vital to developing countries. Thus, the agricultural sector (eg: rice, wheat, coarse grain and beans) and the services sector (eg: marketing and transportation) could be included in the model to evaluate the cross effects. Such a model could allow for quantification of short run and long run effects of each policy and of various policy mixes on sectorial (eg: rice) and key macroeconomic variables (eg: GDP, employment and wages). This would

require input-output data and pre-estimated elasticity parameters which are not readily available especially in developing countries. However additional facilities in terms of time and finance should be considered when deciding on future modelling approach as to be adopted.

Finally the world rice trade model can be developed by dividing rice into japonica and indica rice. Japonica rice is mainly produced and consumed in Australia, China, Japan, South Korea and the United States. Major exporting countries of japonica rice are the United States and Australia and major importers are Japan and Korea. Indica rice is produced and consumed in Bangladesh, Brazil, China, India, Indonesia, the EU(15), Pakistan, Thailand, the United States and Vietnam. Major exporting countries of indica rice are India, Pakistan, Thailand, United States, and Vietnam, and importers are Bangladesh, Brazil, China, the EU (15) and Indonesia. Since China and the United States produce and consume both japonica and indica rice, substitution between these two varieties in rice production and consumption could be allowed in the model.

5.4 Policy implications

Rice is the most important staple food in the poorest countries of the world. Developing countries in Asia are responsible for nearly 90 percent of the global rice production and consumption. Although rice is widely grown and consumed in these countries, less than 5 percent of rice production is traded annually due to trade restrictions. In contrast to the other agricultural commodities, developing countries have much higher levels of rice protection and support than the large developed countries (except Japan) in the world. This analysis suggests that these countries as a group would benefit more than the developed countries if rice supports were removed fully or partially in all the countries. Full liberalisation would increase welfare of the developing countries more than any other alternative policy. This implies that developing countries, as a group would achieve higher gains by participating in the full liberalisation process than relying on liberalisation by developed countries or the URAA. Even though the developing countries in the world are looking forward to another round of negotiations in the World Trade Organisation, the results of this analysis suggest that the agreements may not benefit developing countries. Therefore developing countries such as Bangladesh, China, India, Indonesia, South Korea, Thailand and Vietnam should find strategies for full liberalisation in the rice sector. However spill over effects would vary due to a wide diversity among developing countries in their resource endowments, stage of developing and economic and institutional structures.

Despite the welfare gains that result from trade liberalisation, many governments continue to support their rice industry because in some countries rice supports have become accepted as necessary or even rationalised as being desirable. For an example, if Bangladesh or Vietnam tries to remove consumer supports, they run the risk of increasing malnutrition among the poor, many of whom can barely afford food at any price. Moreover the majority of farm households in Bangladesh do not benefit from the removal of producer taxes that would increase the producer price because they are net consumers of food.

The rice producers in Japan and South Korea depend on government support for a substantial part of their income and for maintenance of their wealth. Any movement to free trade in Japan and South Korea would have profound effects on the domestic rice producers in these countries. A large proportion of resources would be forced from current production. In particular, rice production on the most inefficient small farms would be eliminated. Therefore rice producers exert as much political pressure as they can for its perpetuation. Given the political importance of rice farmers, it is understandable that the governments of Japan and South Korea are reluctant to remove further their rice trade restrictions even under increasing URAA pressure.

Although domestic political factors can impede trade liberalisation and limit economic benefits for countries as a whole, international cooperation can provide a means of reducing those negative factors. If rice supports were reduced or eliminated in all the countries, they would benefit from the comparative advantage arising from trade liberalisation. Thus trade liberalisation with other institutional reforms and infrastructure development would increase economic growth in a country.

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New Zealand's Changing Trade Pattern and Policies

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Abstract

New Zealand is often described as a small open economy that is heavily dependent on agriculture for its export revenues. Although trade constitutes a substantial part of its economic activity, New Zealand is not becoming more open over time. A lowering of average tariff may hide the fact that New Zealand's tariff structure remains stubbornly dispersed. The composition of New Zealand's trade is changing steadily. Over past several decades, agricultural produce has dominated New Zealand's exports, but that dominance is falling monotonically. This reflects the dynamic nature of our international competitiveness. In terms of trade direction, New Zealand has developed its agriculture and manufacturing industries to suit the needs of niche markets. Taking data from New Zealand and its trading partners, this paper provides empirical support to New Zealand's changing trade pattern and examines the policy environment leading to the emergence of these changes.

Keywords: New Zealand, trade specialisation, international competitiveness.

Introduction

New Zealand's small economy is heavily dependent on international trade. Traditionally, a large proportion of New Zealand's exports, mainly agricultural products, went to the United Kingdom. In the past 20 years, however, New Zealand has adapted to a changing world so that Asia is now more dominant. Our largest merchandise export markets are Australia, USA and Japan. New Zealand has developed its agriculture and manufacturing industries to suit the needs of niche markets. Dairy and meat exports still make a large contribution to New Zealand's economy. However, industries such as forestry, horticulture, fishing, manufacturing and tourism have become increasingly significant.

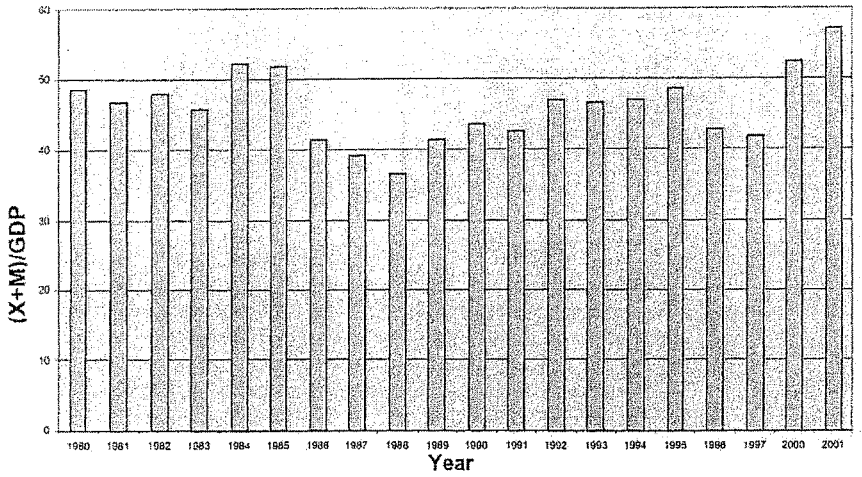
New Zealand's overseas trade and Trade Policies

New Zealand claims to be an (relatively) open economy. For a small, island nation with limited domestic market, an export promotion, rather than an import substitution is believed to be a superior path to follow. Nevertheless, as recently as 1984 New Zealand's trade policy showed a clear bias towards import substitution. New Zealand's export-based farming sector had little to cheer about such strategy. Imported inputs and farm machinery prices meant high cost of production. An elaborate scheme of farm subsidies became complimentary to import substitution policy. Such price-distorting policies led to economy-wide misallocation of resources. Inefficiency and wastes in the protected manufacturing sector, loss of international competitiveness in the farming sector and the fiscal deficits from subsidies all meant an economy at the brink of a disaster. The new Labour government in 1984 had little choice but to step up a campaign of drastic reforms, and trade liberalisation was at the forefront of its reform agenda. New Zealand has little reason to return to pre-1984 protectionist regime. Freer trade allows specialisation, maximum utilisation of endowed resources, returns to scale, and prosperity. But how do we rank as a trading nation?

Measure of openness

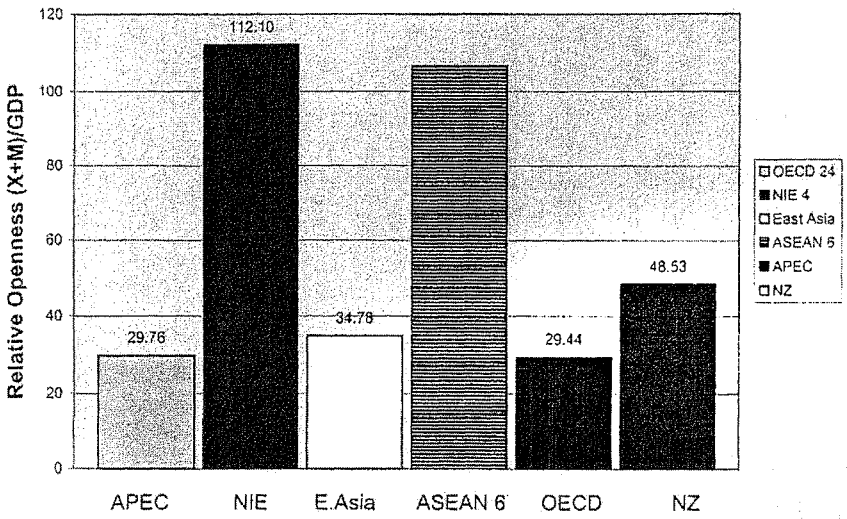
New Zealand is regarded as an open society both in terms of personal freedom and in its external trade relations. In its latest annual report (2002) of the Economic Freedom of the World report published by the Cato Institute, Canada's Fraser Institute and groups in 54 other countries, New Zealand was rated fifth. Among its criteria, freedom to trade with foreigners carries a significant weight. Because the focus of this paper is on a narrower issue of trade, we have used the conventional measure of trade orientation to represent openness, which is the volume of trade relative to GDP (see Pomfret, 1995, pp. 41-43). This measure is used to assess New Zealand's path as a trading nation over time, and to compare its relative standing vis-à-vis its selected trading partners.

Figure 1 NZ Openness Index, 1980-2001



Source: NAPES database

Figure 2 Openness Comparisons



Source: NAPES database (1998)

Two observations can be made in regard to New Zealand's openness. First, although trade constitutes a substantial part of our economic activity, it is not clear that New Zealand is becoming more open over time. In the post-WWII era, New Zealand has emerged as one of the freer trading nations. The path has been less than monotonic. New Zealand's external trade peaked immediately after the sweeping reforms (1984-85). Besides tariff reductions following reforms, floating exchange rate (and the lifting of currency restrictions that comes with flexible dollar) boosted trading. It is generally known that the volume of trade falls during recessionary times. Economic crisis elsewhere, especially in Asia in more recent times have had significant impact on New Zealand's trade relations. Historically, New Zealand was least open during the Asian crisis of 1997-98 (except the recessionary years of 1987-89). Since the crisis, and in the most recent years, New Zealand's external trade has accelerated.

Secondly, using the definition of openness, when one compares New Zealand's external trade with other "similar" economies, it turns out that New Zealand's claim of being a leading open economy is rather exaggerated. Many of the small emerging nations in Asia would be regarded more open when compared to New Zealand. However, compared to large economies, and important trading blocs in the Asia-Pacific region, it would be fair to say that New Zealand is largely a trading economy.

Changing Direction of New Zealand's Trade

Until the 1960s, New Zealand's external trade was heavily biased towards Western Europe. In particular, preferential trading arrangements with the United Kingdom meant the bulk of New Zealand's agricultural produce ended up in one country. In the last twenty-five years New Zealand's trade pattern has changed significantly. Some of the underlying reasons are obvious, while others are not. With Britain's entry in to the Common Market in early 1970's, it also ended Commonwealth preferential trade treatment towards New Zealand agricultural exports. The most important trading partner now ranks fifth from New Zealand's point of view. With increased economic integration in Europe, New Zealand was forced to explore new markets. New Zealand also joined the race forming regional trading agreements with its neighbours. With the signing of the New Zealand Australia Free Trade Agreement (NAFTA, 1965), Australia gradually became a very significant trading partner and the Closer Economic Relations (CER, which replaced NAFTA in1983) agreement sealed top trading partner status (ranks 1 in terms of both imports and exports, see tables 1 and 2). This happened over a period when low energy prices and rapid improvements in container shipping rendered transportation cost as insignificant barriers to trade. Increasing population and double-digit growth in Asia, especially in East Asia also filled gap left by U.K. and other Western European nations quite easily. Japan has established itself as a major trading partner and the relatively small economies of Hong Kong, Korea and Taiwan have emerged as other significant trading partners of New Zealand. The following two tables should attest to these facts. The group labeled "other" includes the smaller nations, many of them from developing Asian region. These countries formed one of the top three export destinations during the observations period. New Zealand has been aggressive in finding new and diversified markets for its produce.

Table 1: New Zealand's Top 10 export Partners

Partner	Indicator	1971	1976	1981	1991	1996	1999
AUSTRALIA	Export	5	4	2	1	1	1
JAPAN	Export	4	3	3	2	2	4
OTHER	Export	3	2	1	3	3	3
USA	Export	2	5	5	4	4	2
UK	Export	1	1	4	5	5	5
KOREA	Export	28	20	15	6	6	6
HONG KONG	Export	16	13	16	11	7	8
TAIWAN	Export	25	18	18	8	8	10
CHINA	Export	35	17	6	10	9	7
GERMANY	Export	8	6	7	7	10	11

Table 2: New Zealand's Top 10 import Partners

Partner	Indicator	1971	1976	1981	1991	1996	1999
AUSTRALIA	IMPORT	2	1	2	1	1	1
USA	IMPORT	4	4	1	2	2	2
JAPAN	IMPORT	3	3	3	3	3	3
UK	IMPORT	1	2	5	5	4	7
OTHER	IMPORT	5	5	4	4	5	4
GERMANY	IMPORT	6	6	8	6	6	6
CHINA	IMPORT	18	18	17	11	7	5
TAIWAN	IMPORT	28	20	13	7	8	11
ITALY	IMPORT	9	11	12	8	9	12
CANADA	IMPORT	8	8	9	13	10	15

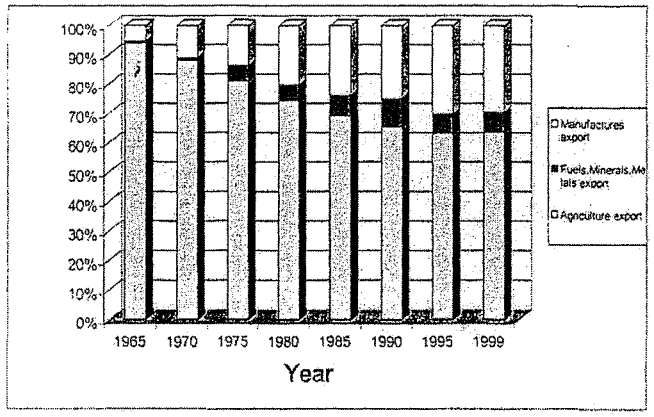
Source: NAPES Database, 20Feb02

New Zealand's trade composition

Historically, relative factor abundance has shaped New Zealand's trade composition. New Zealand's relative land-abundance coupled with other natural factors like high precipitation and moderate year-round temperatures produce most appropriate condition for a prosperous agricultural sector. Accordingly, farming has been, and continues to be the main export earner for New Zealand. Farming sector's contribution has been small in terms of the aggregate economic activity (as measured by GDP), while exactly the opposite conditions hold in terms of trading activity.

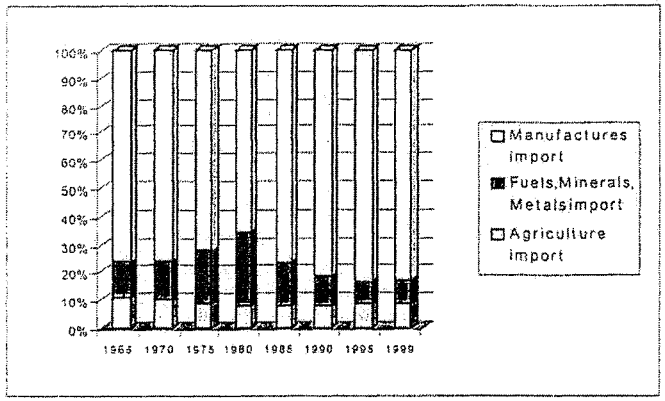
The composition of New Zealand's trade is changing steadily. This reflects the dynamic nature of our international competitiveness. Over past thirty years, agricultural exports have dominated, but that dominance is falling monotonically. The trend is opposite to what has been happening to New Zealand's manufacturing and mining exports- rising from insignificant to respectable numbers. In terms of imports, manufactured products dominate while the share of the other sectors (fuels, minerals, metals and agricultural imports) has been small. Unlike the export counterpart, the share of the dominant sector in imports, namely manufactured imports shows no sign of abatement in more recent years. The volatility of fuel prices means its share in the import bill is equally volatile. For the net trade dynamics, one can calculate the trend in the index of trade specialisation (ITS). The calculated values are reported in table 3.

Figure 3 Composition of NZ's exports, 1965-99



Source: NAPES Database

Figure 4 Composition of NZ's imports, 1965-99



Source: NAPES Database

The Index of Trade Specialisation is defined as each sectors net export in relation to the sum of sectoral exports and imports. That is:

$$ITS_i = (X_i - M_i) / (X_i + M_i)$$

This indicator, therefore, can take on a value between minus one and plus one. These numbers are calculated for assorted years. This indicator does not show a distinct trend for the agricultural sector. The observation is similar to that in Australia where the index has stubbornly stayed at around plus two-thirds with practically no trend until 1950 to early 1990 (Pomfret 1995, p.35). Compared to Australia, New Zealand's net trade remain more specialised in agriculture. For the other two sectors, this indicator is highly negative, but declining. This indicates that New Zealand is gaining competitive advantage in its non-traditional sectors. Such diversification is against comparative advantage principle, nevertheless considered healthy from a competitive advantage point of view.

Table 3 Index of trade specialisation, New Zealand

Net sectoral export as a ratio of the sum of sectoral exports and imports

	1965	1970	1975	1980	1985	1990	1995	1999
Agriculture	0.79	0.80	0.81	0.81	0.80	0.78	0.76	0.76
Fuels,Minerals,Metals	-0.90	-0.86	-0.56	-0.65	-0.39	-0.04	-0.09	-0.11
Manufactures	-0.87	-0.75	-0.68	-0.53	-0.52	-0.53	-0.47	-0.47

New Zealand's trade performance

The most important measure performance in trading with rest of the world is the terms of trade index, defined as the relative price of exports over imports. New Zealand enjoyed excellent terms of trade in the 1960's. Preferential prices for its agricultural exports to Britain are to be credited. However, primary commodity prices have been experiencing a secular deterioration in terms of trade for a very long time, and New Zealand could not be spared from this reality. The worst levels were witnessed in the vicinity of the deregulation period (1982-86), improved during 1988-95, before falling most recently.

Table 4: New Zealand's Terms of Trade (TOT); 1987=100

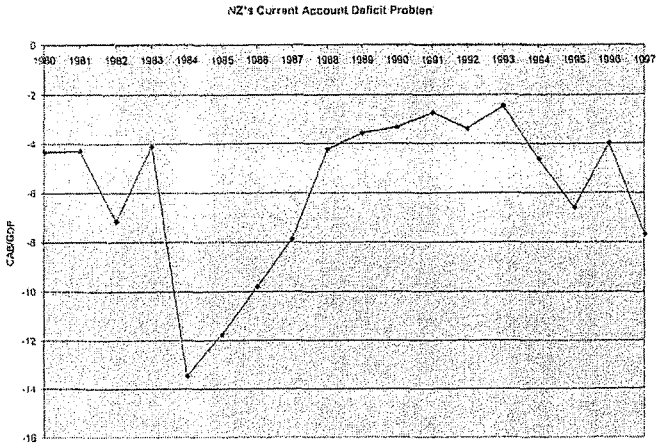
	1965	1969	1980	1982	1984	1986	1987	1988	1990	1992	1994	1996	1997
TOT Idx	132.7	110.8	95.8	94.1	91.6	90.1	100.0	106.7	109.8	105.4	108.1	96.1	94.5
Exp Pr Idx	36.9	30.8	98.2	94.4	85.5	83.6	100.0	117.8	119.8	111.7	121.4	96.8	94.2
Imp Pr Idx	27.8	27.8	102.6	100.3	93.3	92.8	100.0	110.4	109.1	105.9	112.3	116.0	99.6

Source: NAPES Database

Another popular measure of trade performance is stated in terms of current account statistics. Although current account deficits can result from increasing consumer confidence in strengthened economy, the phenomenon is typically associated with weakening performance in external trade. Looking at New Zealand's current account statistics, a deficit is the norm, although modest in a typical year. Since 1980, New Zealand never had a current account surplus, although the deficit has been falling in the most recent quarters.[1]. The actual deficit varied from a low of 2.5% of GDP (1991) to a high of 13% of GDP (1984). A closer look at itemised entries will reveal that the culprit is the "invisibles" trade, rather than merchandise trade. From macroeconomic point of view, chronic current account deficits can be a cause of discomfort. A deteriorating current account deficit preceded the Asian economic and currency crisis of 1997-98. The most severely affected countries of Indonesia, Malaysia, Korea and Thailand all had large and worsening deficit in their current

[1] New Zealand posted its biggest recorded quarterly current account surplus of $732 million in the March quarter of 2002. In terms of annual statistics, a deficit of $2.6 billion at 2.2 percent of GDP is the lowest proportion of GDP in 13 years.

account building up to the onset of the crisis.[2] New Zealand's current account deficit is similar to worse, when compared to these countries. In this sense, the recent volatility of the New Zealand dollar can be linked to more of a fundamental weakness, than one would like to admit.



New Zealand's tariff ranking

Since the reform process began in 1984, New Zealand has reduced its tariff continuously. Currently, about 95 percent of New Zealand imports, by value, are admitted free of duty. Those items that remain dutiable, the tariff rate is generally low, about 5-7 percent. A low, uniform tariff structure is an essential element of a non-distorting tariff regime. However, New Zealand maintains a high tariff rates for a selected range of products. For example, textile and footwear attract tariffs of up to 19 percent, and even more for some clothing imports. Since 1984, New Zealand has moved away from quantity restrictions in administering its trade policy. The poultry sector is an exception in that it enjoys total protection from imports, which are not allowed for phytosanitary reasons. In terms of mean PSE, New Zealand farmers receive less than 3 percent, which ranks them at the bottom of the OECD table. For poultry sector, the PSE remain high (55.3% for poultry meat, 22.2% for eggs in 1997). No other sector recorded more that 3 percent PSE since 1990. Again, it means high dispersion around a very low mean.

Trade liberalisation involving selected sectors is becoming popular in many countries. Examples include APEC's early voluntary sectoral liberalisation and zero-for-zero agreements. From an economic efficiency point of view, such schemes can create new distortions, and their welfare implications can be perverse. Using applied general equilibrium model, Rae, Chatterjee and Shakur (2001) calculated the losses associated with such selective trade liberalisation schemes for a number of countries. In contrast, the benefits of an across-the-board reduction in tariffs were overwhelming.

[2] For a detailed discussion on the topic, see Shakur (2002).

The World Bank ranks 84 countries by their mean tariff, as part of overall measure of openness and international competitiveness. The first 20 of their rankings, based on 1997 applied tariff rates on manufactured imports, are reported in Table 5. Mean tariff is the simple average of the applied rates for all products subject to tariffs. New Zealand's place at seventh, with a mean tariff of 4.5% ranks it above Australia and the US. In fact if one disregards the city-states of Hong Kong and Singapore, New Zealand ranks at the top within Asia-Pacific countries. This is quite remarkable.

The standard deviation of the tariff rates measures the average deviation of the tariff rates around the mean; it is calculated using unweighted tariff data. Highly dispersed rates are evidence of discriminatory tariffs that does not bode well for international competitiveness. This will be further discussed in Section 3.3. In the case of New Zealand, a standard deviation of 6 percent is better than majority of its trading partners but falls little short of the EU countries.

Table 5 Country Ranking by Tariff Rates (Unit- percent)

Ranking	Country	MeanTariff	Standard Deviation
1	SWITZERLAND	0.0%	0.0%
2	HONG KONG, CHINA	0.0%	0.0%
3	ESTONIA	0.1%	1.2%
4	SINGAPORE	0.5%	2.7%
5	MALI	3.0%	2.4%
6	NORWAY	4.1%	16.5%
7	NEW ZEALAND	4.5%	6.0%
8	UNITED ARABS EMIRATES	4.5%	N/A
9	LITHUANIA	4.6%	9.2%
10	COTE D' IVOIRE	4.8%	1.1%
11	UNITED STATES	5.2%	11.8%
12	AUSTRALIA	5.3%	7.4%
13	JAPAN	5.7%	7.7%
14	EL SALVADOR	5.7%	7.9%
15	OMAN	5.7%	9.2%
16	NICARAGUA	5.9%	7.3%
17	LATVIA	6.0%	10.7%
18	ITALY	6.7%	5.8%
19	DENMARK	6.7%	5.8%
20	UNITED KINGDOM	6.7%	5.8%

Conclusion

Trade has been important to New Zealand's agriculture and an integral part of its overall economy. New Zealand's prosperity is directly linked with its ability to find niche markets for its value-added products and securing better prices for its primary commodities. New Zealand's trade intensity has shown volatility in the past and a declining trend in recent years. As is true in other trading economies, a recessionary environment generally adds fuel to slow the process of trade liberalisation. New Zealand's previously declared policy of removing all tariffs by 2006 is currently under hold. The freeze ends on 1 July 2005 and the government is currently undertaking a broad based review of its tariff policy. Although some revision of policies is justified in exceptional times, protectionism and inward looking policies cannot be a viable option for New Zealand. Inability or unwillingness to open trade will mean under-utilisation of out abundant natural resources and impoverishment. This applies to rest of the world as much as it does to New Zealand. Since WWII, trade has been the engine of world-wide growth. But protectionist forces are still alive. New Zealand's performance and place in the global economy will be shaped by its external trade policy.

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Climate change policies, green house gas emission reductions and the New Zealand economy

by

K. Fatai*, F. Scrimgeour** and L. Oxley***

Abstract: New Zealand had planned to implement global climate change policies. Global climate change policies are likely to alter the comparative advantage that different economies have in international trading. To estimate these changes we use a Leamer type energy resource profile to estimate the change in the distribution of comparative advantage in New Zealand and its trading partners. The paper also seek to estimate the cost, both at the economy level and sectoral level, of implementing climate change policies for various options that policy makers can choose from such as using a command and control approach directly control emissions to the Kyoto approach of domestic and international emission trading. We used an alternation of the GTAP-E model, a global CGE model, that could be effectively used to simulate emission trading between different sectors of the economy, as well as between different regions and countries that New Zealand may like to trade its GHG emissions with.

Keywords: Emission trading, New Zealand, CGE

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1 INTRODUCTION

From an environmental perspective, global warming is a global phenomenon as emission of greenhouse gases (GHG) anywhere would have uniform impact on the environment globally. The fact that global temperature have more than doubled during the past two centuries (see figure 1) showed that the effect of GHG on the environment have substantially increased especially during the last few decades. Also, scientific evidences amassed by three working groups[1] of the, UN sponsored, Intergovernmental Panel on Climate Change showed that global temperature increase, especially during the last five decades, is mainly due to human activities particularly by some high GHG emission countries. The effect of these human activities is global because of the global increase in temperature. They also estimated that about 60 million tons of CO_2 are, globally, emitted daily. This trend, if it continues, will disrupt both the environment and human activities, hence, if there are no international efforts to combat global warming, our civilization will be threatened in a few decades from now.

International effort reached a milestone in 1997 when the Kyoto protocol to the United Nations Framework Convention on Climate Change was established with the agreement that each country listed in Annex 1 would work to reduce GHG. According to Article 3 of the protocol, Annex 1 members will work to reduce GHG equivalent emission by about 5% from their 1990 level in the first phase of the agreement. Further agreement in Bonn 2001 and Marrakes 2001 confirmed the strategies agreed by all parties to cut down GHG. New Zealand is an Annex 1 party and, with the leading role played by the government, have every intention to play a international leading role in implementing the protocol. New Zealand's target is to keep its emission in the first phase (2008-2012) of the agreement at their 1990 level. This turns out to be about 78.2 million tons of CO_2 equivalent (Pricewaterhouse Coopers, 2001). This may mean that when the government ratified the Kyoto Protocol, it may probably be issued with about 364 million tones of Assignment Amount Units or AAU, which may be traded domestically and/or internationally.

There are, however, issues that New Zealand might face and therefore should be studied. These issues are generally related to the economic and social impacts of the protocol both on the New Zealand economy as well as the New Zealand people. This is important because while GHG in other places may affect the environment globally, mitigation of GHG may have different economic impacts in different countries and/or regions. For example, international studies showed that, on average, the cost curves of GHG emissions are generally higher in developed countries and lower in developing countries. It follows that for developed countries, like New Zealand, effort to reduce GHG emissions is likely to be more costly than in developing countries. The economic solution is to mitigate GHG emissions wherever it is cheapest.

In the New Zealand literature, there had been some works that have discussed the likely economic impact of the protocol. Two important studies are worth mention. The first is a study by ABARE focusing on the effect of the Protocol on mainly the agricultural sector. The second study was done by the New Zealand

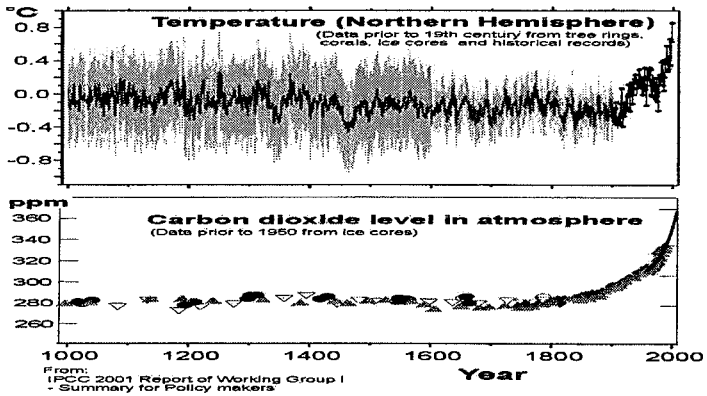
[1] See http://www.gsnz.org.nz/gsprpb.htm for a summary of what these three working groups have done.

Institute of Economic Research (NZIER), focusing on energy related sectors and their economic impacts. This study also focuses on the impact of the energy sector on the rest of the economy. However, rather than using a single country CGE, we use a global CGE realizing the intricate connection and link with the world market. The model used by the ABARE report was a global CGE model known as GTEM. It tends, however, to focus predominantly on impacts of shocks on the agricultural sector.

The model that we use to quantify the economic consequences for the New Zealand economy is also a global CGE model. The global CGE model is designed specifically for the energy sector and is known as the GTAP-E model, where E stands for energy. The model allows for inter-fuel and inter-factor substitution and also for modeling of carbon emissions (Truong, 1999, Truong, 2001). We use a slight modification of the GTAP-E model – we firstly modify the GTAP-E model by including the agricultural sector in the 'bad' sectors, such as coal, oil, electricity and petroleum sectors, because the agricultural sector accounts for about 55 percent of the emission of non-carbon dioxide greenhouse gas emissions. The other slight alternation is the aggregation, which specially focus on New Zealand and some of its important trading partners. Since the announcement by the government that the agricultural sector will be exempted from any emission levy during the first period of the agreement, we decide to exclude the agricultural sector from the 'bad' sectors so that our model closely resembles the most recent reality in the New Zealand energy sector. So we end up by adding two extra modules to the GTAP-E model to enable us to simulate domestic and international emissions trading.

The paper has six further sections. The second section briefly describes the main source of greenhouse gas emissions in New Zealand followed by a brief literature review in the third section. The fourth section also briefly describes the model that we are using. The fifth section describes the experiments followed by a discussion of the empirical results in section six. The last section summarizes the main findings and concludes.

Figure 1: Northern Hemisphere temperature and GHG emissions.



2 GREENHOUSE GAS EMISSIONS SOURCES IN NZ: 1990-1999

For many years, the largest sector in the New Zealand economy was the agricultural sector. Although the agricultural sector has decreased gradually, while other sectors such as the service sector and financial sector, are increasing steadily, it still remains that, in terms of greenhouse gas emissions, the agricultural sector still contributes a large portion of New Zealand's total greenhouse gas emissions. This is because of the large number of farm animals, which contribute significantly to the emissions of methane and nitrous oxide into the atmosphere.

Table 1 presents the sources of greenhouse for New Zealand for the period 1990-1999. In the latest statistics available, carbon dioxide (C02) accounted for about 40% of total greenhouse gas emissions in 1999. In 1990 it accounted for about 35% of total greenhouse gas emissions. The growth of 5% is small and mainly due to the emissions by the growing transport sector and energy generation industries (NZIER, 2002).

Table 1: New Zealand's greenhouse gas emissions in CO2 equivalent (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Carbon dioxide	25,399	25,882	27,763	27,136	27,199	27,206	28,223	30,210	28,824	30,523
Methane	35,211	34,478	33,857	33,896	34,105	34,144	34,103	33,494	33,558	33,594
Nitrous oxide	11,849	11,725	11,738	11,887	12,048	12,097	12,041	12,062	12,231	12,397
Other	605	653	646	247	300	310	414	384	397	318
Total	73,064	72,737	74,004	73,166	73,651	73,757	74,782	76,151	75,010	76,831

Note: 1 Source: NZIER (2001) and Ministry for the environment (2001)
2 Others refer to hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride
3 Gg refers to gigagram which equals one kiloton

The emissions of methane (CH4), on the other hand, went up from about 45% in 1990 to about 48% in 1999. It is believed that methane's overall contribution to global warming is very significant given that it is estimated to be a better emission to trap heat in the atmosphere. In fact, it is about 21 times more effective than carbon dioxide, the main gas emissions in earth's atmosphere. The greatest contribution to this increase was from farming livestock. Methane emission in the farming sector is largely due to enteric fermentation in livestock and manure management. Between 80-90% of methane emissions were from ruminants. In the United States, methane emissions from the agricultural sector accounted for only 28% of the total methane emissions. This shows that the agricultural sector contributes significantly to New Zealand's total greenhouse gas emissions.

Nitrous oxide (N20) is the third main greenhouse gas emission in New Zealand, accounting for only 16% of the total greenhouse gas emissions. Nitrous oxide is significant because it is about 310 times more effective in trapping heat in

the atmosphere than carbon dioxide. The main contributors of nitrous oxide are agricultural soil management and fuel transport combustion.

The implication, for at least the agricultural sector, of these statistics is that to reduce greenhouse gas emissions the agricultural sector should play an important role. However, the disadvantage for the agricultural sector is that the only viable way to reduce methane gas emissions from pastoral animal is to reduce the number of heads. This would significantly alter New Zealand's agricultural exports, in particular, export of wool and dairy products – the two most significant contributors to New Zealand's total export revenue. The good news for the agricultural sector, however, is that they will be exempted from any emission levy in the first period of the Kyoto agreement (2008-2012). However, the government expects the agricultural sector to come up with viable solutions for the second period of implementing the Kyoto protocol.

3 OBSERVATIONS FROM THE NEW ZEALAND LITERATURE

Although there have been quite a number of studies in New Zealand modeling the impact of environmental control costs, the observation by Dean (1992) "numerous studies have tried to estimate the impact of environmental control costs (ECC) on industry price and output, and on trade balance. ...The methodologies are quite varied, making comparisons between studies very difficult. Some overseas studies (Tobey 1990; Xu, 1998; Ratnayake, 1996; Ferrantino, 1997) concluded that environmental standards is likely to have no significant impact on the competitiveness of some industries. However, this is not so with models that have analysed the likely impact of the Kyoto Protocol on the competitiveness of some sectors of the New Zealand economy. The NZIER and ABARE CGE model both concluded that constraint of the Kyoto Protocol on the agricultural sector in New Zealand will not help the competitiveness of the New Zealand agricultural sector, as well as other sectors of the New Zealand economy.

The ABARE (2001) model of the impact of the Kyoto Protocol on New Zealand found some sectors of the New Zealand economy is likely to move away from energy intensive sectors such, as agriculture, and electricity production, to less energy intensive sectors. In the electricity generation sector, there may be a shift in the shares of electricity generating technologies with the use of coal consumption for generating electricity may decline while gas electricity generators is likely to increase. In the agricultural sector, there may be a movement away from meat production, which has high methane emissions, towards crop production. The rising costs of production resulting from such change may lead to changes in the terms of trade. Iron and steel production will be hit hard because of their high carbon emissions. Other scenarios were also simulated, and generally, the scenarios (six in all) seem to show that high energy intensive sectors may decline and there may be a move towards low energy intensive sectors.

The NZIER report concluded that, if New Zealand implements the Kyoto Protocol in the first period, "the economic effects are likely to be substantial. People's livelihood and living standard adversely affected" (p.iv). GDP growth will decline with negative implications for household income and consumption. Both household consumptions and income were projected to decline for most of the scenario simulations. Real wages will decline for all of the ten scenarios simulated. At such, the government should approach the Kyoto Protocol "cautiously" and should not rush to implement the Kyoto Protocol fully until the full effects are recognized.

Both the ABARE report and the NZIER report show significant impact on the New Zealand economy. However, while both uses a single country CGE, this model uses a multi-country global CGE to answer some of the questions that were answered by the above two reports as well as some questions that were not answered by the above two CGE models. The fact that we are using a modified version of GTAP-E allows us to answer other questions that are deemed important to answer.

4 THE GTAP-E-NZ MODEL

This section will provide a brief overview of the GTAP-E model based on the work by Hertel (1997) as well as the graphical overview by Brockmeier (1996) and particularly the detailed description of the structure in Truong (1999).

4.1 Bottom Up versus Top Down

The two common approaches to modeling interaction between energy and the environment using CGE are commonly known as the bottom up and the top down approach. They differ mainly in their treatment of the energy system and the theoretical treatment of the economy. The bottom up approach is mainly a partial model of the energy system with no linkages to the rest of the economy. This type is mainly engineering type approach to modeling the energy system with high emphasis on the energy system and its different components. The main issue tackled by this type of model is the least cost way for an economy or organization to meet energy demand with a number of constraints such as exogenous carbon emissions. The second approach is mainly economic models where the energy sector may be more aggregated than the engineering approach. The approach uses microeconomic theory such as neoclassical production function with inter-factor substitution through substitution elasticities. Recently, energy models also incorporate inter-fuel substitution with corresponding inter-fuel elasticity to model the mixture of fuel that minimize costs of production. Such model tries to capture the feedback effect of changes in the energy sector on other parts of the non-energy market. The model that we use is a top-down approach with particular emphasis on the energy sector.

4.2 The Model

GTAP-E is an extended version of the GTAP model, which is documented in detail in Hertel (1997). Both GTAP and GTAP-E are static, multisector, multiregional computable general equilibrium model of the global economy. Among its notable feature is the comprehensive dataset for more than 40 countries and regions as well as more than 45 commodities and industries; a global bank that collects saving and allocate them to investments by industries and regions; and the formulation of consumers sectors that allows consumers to respond differently in response to changes in price and income across commodities and regions. GTAP,

however, does not explicitly model the energy sector to allow for interfuel substitution.

GTAP-E, the extended version of GTAP, explicitly model the production stucture to take into account the possibility of substitution between different sources of energy as described in Vinals (1984). This specification of the production structure was not modeled in the original GTAP model. Other CGE models that focus on the energy sector basically follows the same production structure in modeling interfuel substitution (Zhang, 2000). The major difference of these models with GTAP-E are that these models are individual country CGE while GTAP-E is a global CGE with a new comprehensive global data set of the energy sector that is added to the original GTAP dataset (Truong, 1999).

In our GTAP-E-NZ model we included the agricultural sector as a 'bad' commodity in addition to oil, gas, coal and petroleum products in the original GTAP-E model. In this specification, the agricultural sector is a 'bad' commodity because of the CHG emissions that accounts for about 55% of the New Zealand's non-carbon emissions (NZIER, 2001). However, the latest development the energy sector is exempted from any levy during the first period of the Kyoto agreement. So this specification was excluded in our model. Readers interested in the effect of CHG reduction in the agricultural sector are referred to the CGE model used by NZIER (2001). The NZIER found that reduction of emissions in the agricultural sector have significant negative effects on production because the reduction in non-carbon emissions can only be achieved by reducing the number of heads in animal farms.

In GTAP-E, each region has an additional market for non-energy goods (non-E goods), electricity (ely) and non-electric goods (non-ely). Non-ely is made up of oil, gas and coal. These sectors are used to produce final energy goods, which are further used either as an intermediate product or sold as a final energy product. The household sector in each region is represented by a consumer, who buys final products to maximize utility subject to a budget constraint. The representative consumer supplies capital, labour and energy resources as inputs to production. The final production from productions are traded in the international market. The exception is electricity, which is not traded globally. The trade flow is facilitated by a transportation sector, which charge a price for the services they have offered.

4.3 Model Formulation

A detailed description of the model formulation can be found in Hertel (1997) and Truong (1999). In this section we will present a brief overview of some of the important aspects of the GTAP-E model. Perhaps, the major difference between the GTAP-E model is the additional choice for firms. That is, they can either substitute between different fuel sources and also between different factors.

The production function for the GTAP-E model is shown in figure 1 below. The main difference from the standard GTAP model is the capital-energy substitution and substitution between different sources of energy. This is important as the increase or decreased in output growth may depend on the substitutability between capital and energy as well as between different energy types (Vinals, 1984).

The GTAP-E model, however, cannot specifically deal with the Kyoto Protocol trading because of its structure. This is overcome by adding two new modules to GTAP-E. The two modules divide the countries and regions into emission trading (ET) and non-emission trading (NET) countries and regions. Also, the sectors are divided into either emission trading sector (ETS) or non-emission trading sector (NETS). With this division of countries and commodities, one is able to simulate different outcomes resulting from countries engaging in both domestic and international emission trading.

4.4 Data Sources, Elasticity and Model Calibration

The data source that we use include the dataset from v.4 of GTAP and dataset from the International Energy Agency which include detailed data on the energy volume demanded by each of the regions or country in GTAP v.4. This information is combined with the standard GTAP dataset to make a new dataset – the GTAP-4E dataset.

The full dataset have 50 industries and commodities and 45 different countries or regions. Because the capacity of the computer we use cannot do any simulation with the full dataset, we therefore aggregate the commodities and industries into 10 industries, which is mostly made up of energy commodities.

The commodities are agriculture, coal, oil, gas, minerals, chemical and rubber and coal products, ferrous and other metals, manufactures, electricity and gas and water, and services. The industries are the same as the commodities. We also aggregate the regions into 10 regions to reflect the countries that New Zealand trade with and other high carbon emission countries such as China and India. The regions are Australia, US, Japan, EU, NEX, NEM, China, India, New Zealand, FSU.

Table 2: Sectors in the Model

	Domestic emission trading	No domestic emission trading
COL	No_Dom_Trade	No_Dom_Trade
OIL	No_Dom_Trade	No_Dom_Trade
GAS	No_Dom_Trade	No_Dom_Trade
P_C	No_Dom_Trade	No_Dom_Trade
ELY	No_Dom_Trade	No_Dom_Trade
SER	No_Dom_Trade	No_Dom_Trade
CRP	No_Dom_Trade	No_Dom_Trade
OMN	*Yes_Dom_Trade*	No_Dom_Trade
AGR	*Yes_Dom_Trade*	No_Dom_Trade
I_S	*Yes_Dom_Trade*	No_Dom_Trade

Yes_Dom_Trade = Domestic emission trading sectors

No_Dom_Trade = No domestic emission trading sectors

E_U is made up of Germany, UK, Denmark, Sweden, Finland, Rest of European Union. NEX is made up of Indonesia, Malaysia, Viet Nam, Mexico, Venezuela, Colombia, Rest of Andean Pact, Argentina, Rest of South America, European Free Trade Area, Rest of Middle East, Rest of North Africa, South African Customs

Union, Rest of Southern Africa, Rest of Sun Saharan Africa, Rest of World. NEM, on the other hand, is made up of Canada, Philippines, Singapore, Thailand, Korea, Hong Kong, Taiwan, Sri Lanka, Reest of South Asia, Central America, Caribbean, Brazil, Chile, Uruguay, Central European Associates, Turkey and Morocco. Here we follow the categorical division in Hamasaki and Truong (1999).

Table 3: Regions in the Model

Regions	International emission trading	No international emission trading
NZ	*Yes_Inter_Trade*	No_Inter_Trade
AUST	*Yes_Inter_Trade*	No_Inter_Trade
JPN	*Yes_Inter_Trade*	No_Inter_Trade
USA	No_Inter_Trade	No_Inter_Trade
E_U	No_Inter_Trade	No_Inter_Trade
FSU	No_Inter_Trade	No_Inter_Trade
CHN	No_Inter_Trade	No_Inter_Trade
IND	No_Inter_Trade	No_Inter_Trade
NEX	No_Inter_Trade	No_Inter_Trade
NEM	No_Inter_Trade	No_Inter_Trade

Yes_Inter_Trade = International emission trading regions
No_Inter_Trade = No international emission trading regions

In the simulations, some industries were allowed to engage in domestic emission trading and others were not. For the domestic emission simulations, we allow three sectors (OMN, AGR and I_S) to engage in domestic emission trading. The rest of the industries do not engage in domestic emission trading. The categorizations for domestic emission trading sectors are presented in Table 2. The same was done for international emission trading, where three countries were allowed to engage in international emission trading while the rest of the regions were not allowed to trade their emissions. The categorizations of the regions are presented in Table 3.

4.5 Comparative Advantage

The effect of the Kyoto Protocol can go far beyond the quantitative costs estimated by many energy CGE and energy econometric models. The Kyoto Protocol allocates emission rights, which allows a country or regions to emit a certain amount of greenhouse gas emissions. This emission right can be seen as a new factor of production that can affect production. This new factor of production would fundamentally alter the relative factor endowments of a country, which in turn would alter the comparative advantage for that country, as argued by neoclassical theory of trade, which forms the basis of global trade model such as GTAP and many other CGE models. This change is possible to happen since non-Annex 1 countries does not have this new factor of production hence are not constraint by the Kyoto Protocol.

In the Leamer (1984) study, a country in a region has relative abundance of a resource if its endowment of that resource is relative to the global endowment if the resource exceeds the share of its GDP in total world GDP. Leamer argued that this is the implication of neo-classical theory of trade that forms the basis of global CGE models like GTAP. If we assume that the endowment of a resource of a country is X_i and the world endowment of that commodity is V, then the Leamer index is equal to $Z = \frac{V_i}{V} \Big/ \frac{W_i}{W}$ where W_i is that country's GDP while W is the world GDP. This is further transformed by the equation $y = \frac{5x-5}{x+5}$. If the country does not have any comparative advantage in the resource, y equals –1. But if it's endowment share equals its income share then y = 0. If the country has resources approaching infinity, then y equals 5.

Because the Kyoto Protocol is not a global agreement, the Leamer index needs a slight modification. Non-annex 1 countries are given a value of 5, which seems to give them comparative advantage is emission intensive industries (Leamer, 1984). Also, the estimation of the Leamer indices is only done to Annex 1 countries while non-annex 1 countries are arbitrarily given comparative advantage is emission intensive industries. This is also makes it easier for comparison amongst annex 1 countries and regions.

The results of our estimation are presented in Table 4. The results for the emission intensive industries show that Former Soviet Union, Europe and New Zealand have comparative advantage in emission intensive industries. In the New Zealand case, the positive Leamer

Table 4: Leamer Indices

Country/Region	Labour	Capital	land/natural resource	emission permits
Australia	-0.05	0.51	-0.52	-0.21
NZ	-0.31	-0.23	0.23	0.34
US	0.18	-0.22	-0.62	0.33
Japan	0.07	0.94	-0.74	-0.19
China	1.75	-0.12	1.01	-0.85
India	1.02	-0.21	1.04	-0.63
FSU	0.27	-0.11	0.14	0.38
EU	1.52	1.32	1.07	0.20
NEX	-0.40	-0.020	0.69	5
NEM	-0.15	-0.21	1.43	5

of 0.34 shows that New Zealand's comparative advantage lies in emission intensive industries such as the agricultural sector, in particular dairy and meat, and industries such as forestry and wood products as well as aluminium and petrochemical products. USA also has comparative advantage in the emission intensive industries. Countries or regions that are well endowed with emission intensive industries are likely to be well endowed with capital as well. New Zealand, however, is a little different because its comparative advantage mainly lies in the agricultural sector, which is not as capital intensive as in other industries like steel and metal manufacturing industries. The Kyoto protocol may result in a movement away from energy intensive industries if the cost of emission is too high for emission intensive industries. This may be the case for the EU, which is richly endowed in emission

industries as well as capital goods. New Zealand, however, is well endowed with agricultural resources. However, it may be very hard for New Zealand to move away from where its comparative advantage lies because of the potential cost to the country. In this context, it is better for New Zealand to develop technologies that could to help reduce GHG emission in the agricultural sector.

5 Experiments

We design two main set of experiments to compare with the reference case. In the reference case, we only allow New Zealand to reduce its GHG level to achieve its Kyoto target. The rest of the world, therefore, has no obligation to reduce their emission levels. In the first set of experiments, we tested the likely impact of emission trading by sectors, that is, intra-regional or intra-national emission trading. In this first series of experiments, some sectors within a region or country are allowed to trade emission while others are not allowed. In the second series of experiments, we simulate the likely impact of emission trading at the inter-regional or inter-national level. In the second series of experiments we assume that New Zealand as well as Australia and Japan are all participating in inter-national or inter-regional trading of emission rights. In the second series of experiments we do not allow domestic emission right trading within these three countries. This may encourage non-Annex 1 countries to increase their GHG emission levels, commonly known as the "leakage effect". A summary of the experiments is presented in Table 5.

Table 5: The Experiments

Regions	First Set of Experiments						Second Set of Experiments					
	Reference			Experiment 1			Reference			Experiment 2		
	K	DET	IET	K	DET	IET	K	DET	IET	K	DET	IET
NZ	√			√	√		√			√		√
USA												
CHN												
IND												
JPN							√			√		√
FSU												
E_U												
AUST							√			√		√
NEX												
NEM												

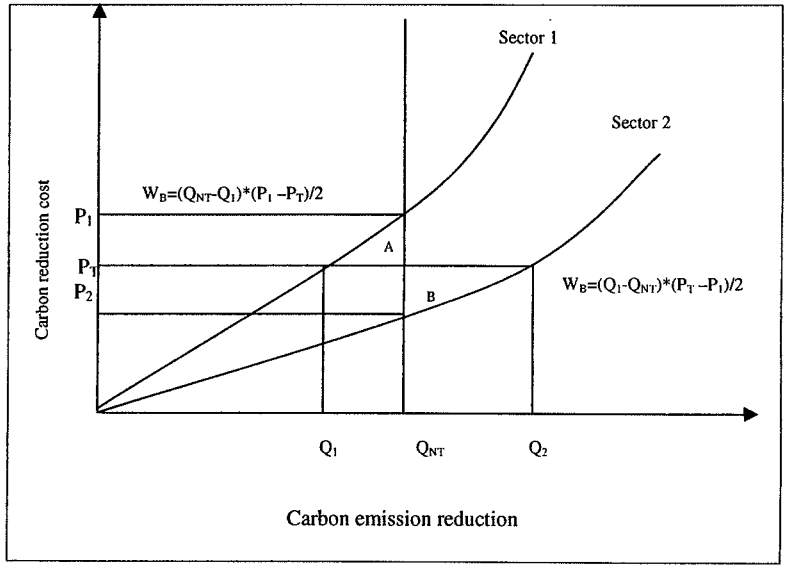
K = Kyoto target; DET = Domestic emission trading; IET = International emission trading.

6 RESULTS

From an economic point of view, there are welfare gains to be made if there is emission trading. This can be illustrated by figure 2 taken from Hamasaki and Truong (1999). In their illustration, they assume that there are two sectors namely

sector 1 and sector 2. In sector 1, its marginal reduction cost of emission is higher than the marginal reduction costs in the second sector. If there is legislation for these two sectors to reduce their emissions by the same amount, say Q_{NT}, both sectors will face different reduction costs. Because they have different marginal reduction costs, the marginal cost to sector 1 for reducing its GHG to Q_{NT} will be P_1 while for the second sector, with a lower marginal reduction costs, the marginal cost will be lower at P_2. If the two sectors formed a protocol allowing them to trade their emissions then both sectors will face the same marginal cost equal to P_T. The high reduction cost, sector 1, will reduce its emission to Q_1 while the lower marginal cost sector, sector 2, will be at the quantity Q_2. From the diagram, we can see that both sectors have welfare gains from trading their emissions. Sector 1 will gain by the triangle A, while sector B will gain by the triangle B.

Figure 2: Welfare gains from emission trading



For the high marginal reduction cost sector, the gain is from buying the surplus from sector 2 at a lower price, P_T, then its own marginal reduction cost of P_2 when there is no emission trading. For the lower marginal reduction cost sector, sector 2, the gain is from selling its surplus emission reduction to sector 1, at a price higher then its own marginal reduction emission cost of P_2. The total welfare gain is given by the equations W_A and W_B for sector 1 and sector 2, respectively.

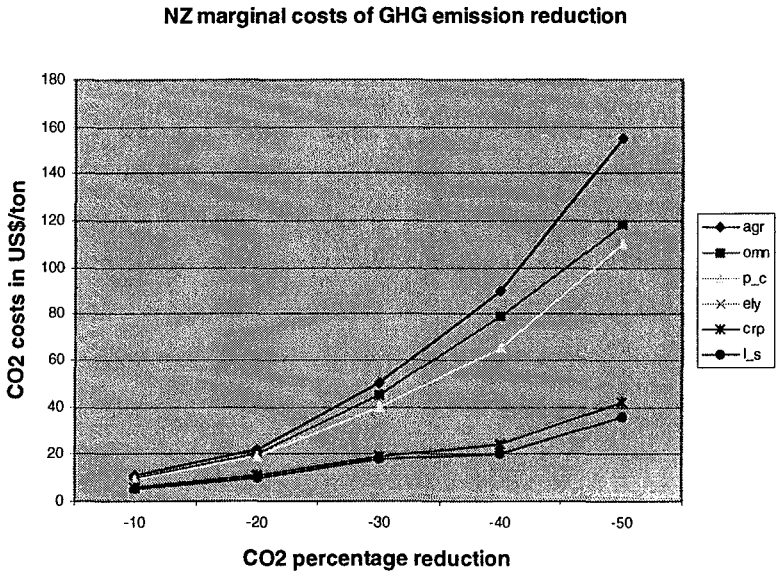
6.1 Domestic Emission Trading

We first simulate the likely changes when there is only domestic emission trading in three chosen sectors. These sectors are the I_S, CRP and OMN sectors following Truong (1999). In our reference case, these sectors are required to reduce

their emission by targeted percentage but without domestic trading. In our first experiment, these sectors are required to reduce their emission by the same percentage as in the reference case but with domestic trading. The other seven sectors that do not trade are required to reduce their emissions level but without domestic emission trading.

Figure 3 shows the marginal costs for each of the sectors when New Zealand does not participate in any emission trading. In table 6, we present the result when chosen sectors reduce their emissions but with no trading. The result shows that the marginal costs of emission reduction is highest in sectors like agriculature (AGR), petroleum products (P_C) and the metal, mineral, transport and paper products (OMN) and lowest for sectors such as ferrous metals (I_S) and electricity (ELY).

Figure 4: Marginal costs of emission reduction in New Zealand



This implies that it is likely to be most expensive if the agricultural sector reduces its emission while it is less expensive to reduce emissions in the I_S and ELY sectors.

Table 6 presents the results when there is both domestic emission trading and no domestic emission trading policy. Previously, we identified that the sectors such as the AGR and the OMN sectors have the highest marginal abatement costs when there is no domestic emission trading. It follows that the profit will be highest when these high and low costs sectors engage in domestic emission trading. In the no emission trading case, in the last three columns, the difference between the high marginal abatement costs sectors (AGR and OMN) and the low marginal abatement cost sector (I_S) is quite high with an abatement costs of $US65.2/tonne CO_2 and

$US54.2/tonne CO_2 for AGR and OMN, respectively, but only $US7.2/tonne CO_2 for the low marginal cost abatement sector I_S. If follows that if there is trading between the low abatement cost sector I_S with the highest abatement cost sector AGR, the welfare benefit may be the highest ($US72.3 million for AGR and $US53.5 million for I_S).

Table 7 shows the results of the effect of domestic emission trading on the production levels of the sectors that were allowed to trade emissions. It shows that the percentage change in sector output seems to improve in high marginal abatement sectors, while it is lowest in low abatement cost sectors. Truong (1999) explained that for simulations of the Japanese economy and the change in the production levels of the sectors in their model, the high marginal costs sectors benefited from trading because it is likely to increase its emissions as doing so will benefit them. Increasing the high marginal cost sectors emissions meant that their production level will also increase. However, this is not the case for the low marginal cost sector I_S.

Table 6: Abatement costs with emission trading and no emission trading: Experiment 1

	Emission trading		No emission trading		Welfare change
	Abatement cost US$/tons of CO_2	Carbon abatement millions tons	Abatement cost US$/tons of CO_2	Carbon abatement millions tons	($US million)
AGR	16.4	35.7	65.2	50.2	72.3
OMN	16.4	10.3	54.2	47.2	41.3
I_S	16.4	46.5	10.2	20.2	53.5

The I_S sector is likely to reduce its production level as doing so will be most beneficial for them because of the fact that their loss in reducing their production level will be compensated by the high cost emitters.

It is also possible that if NZ is the only country engaged in domestic emission trading, internal changes in the output of the energy intensive sectors may also impact the international market. This has been proved to be true in the case of Japan and the US (Truong and Hamasaki, 1999). Other regions which do not engage in any emission reduction is likely to change their level of production, hence their level of emission, if NZ engage in domestic emission trading.

An example of this would be the effect of reducing production in some sectors of the NZ economy. It is likely that the other regions' production level for this sector is likely to increase.

Table 7: Sectoral results (percentage change in sector output for NZ) with and without domestic emission trading

	Emission trading: domestic	No domestic emission trading	Effect of Domestic emission trading on the sector
GAS	-1.02	-1.65	improve production

OIL	-0.42	-0.97	improve production
COAL	-.0.23	-0.52	production not improved
ELY	1.65	1.02	improve production
P_C	-1.95	-1.31	improve production
CRP	-0.63	-0.96	improve production
OMN	-0.54	-0.73	improve production
AGR	-0.8	-0.22	improve production
SER	-0.06	-0.33	improve production
I_S	-0.52	-0.42	production not improved

Hence, their emission level for this sector is likely to increase. Thus, we observe that while the NZ production level of the I_S sector is going to decrease, other regions production in the I_S sector increase.

The results from Table 8 show that Japan seems to be a loser as both the no domestic emission trading and the domestic emission trading scenarios have negative percentage changes in the emission traded products. In the no emission trading case, the negative percentage change in Japan is compensated by the positive percentage change in all other sectors including New Zealand.

Table 8: Percentage changes in the ten sectors when NZ engages in domestic emission trading

	NZ	JPN	CHN	IND	USA	AUS	FSU	E_U	NEX	NEM
No Domestic Emission Trading										
AGR	0.25	-0.34	0.21	0.06	0.08	0.21	0.20	0.10	0.24	0.24
CRP	0.13	-0.85	0.19	0.12	0.14	0.24	0.20	0.20	0.20	0.21
I_S	0.08	-0.31	0.23	0.05	0.04	0.13	0.14	0.07	0.17	0.12
Domestic Emission Trading										
AGR	0.41	0.41	0.31	0.14	0.07	0.35	0.51	0.16	0.31	0.32
CRP	0.18	0.51	0.14	0.09	0.08	0.31	0.12	0.15	0.15	0.15
I_S	0.15	0.23	0.21	0.02	0.09	0.18	0.11	0.04	0.10	0.08

When domestic emission trading is allowed between New Zealand and Australia and Japan, there is an improvement in the percentage changes for all regions. The improvement in New Zealand, Australia and Japan is matched by a negative change in the direction of change that domestic emission trading is causing in some countries. For example, China and India is worse off in the CRP and I_S sectors when there is domestic emission trading between New Zealand, Japan and Australia. This may be due to the fact that the increase in output of the AGR, CRP and I_S sectors in New Zealand, Japan and Australia is matched by the worsening off these sectors in both China and India. This is related to the leakage effect of emission trading where a decrease in emission of one country encourages other regions or countries to increase their emissions.

6.2 International Emission Trading

In the case of international emission trading, we allow some regions to engage in international emission trading while the rest do not engage in emission trading. In particular, we allow New Zealand to engage in international emission trading with Australia and Japan. In our reference model, no country or region engages in international emission trading. The results of the experiments that allow international emission trading are presented in the next three tables.

From table 9 and table 10, we can see that if New Zealand engages in international emission trading there are potential benefits as its marginal emission reduction costs will decrease. This is also the same with Japan and Australia. When all three regions engages in emission it will beneficial for each country to trade to the point that the marginal emission reduction costs for all three countries are equal. The differences in the marginal emission reduction costs between New Zealand, Australia and Japan implies that all three countries will gain if they engage in emission trading.

Table 9: Abatement costs with international emission trading and no international emission trading: Experiment 2

	International Emission trading		No international emission trading		Welfare change
	Abatement cost US$/tons CO_2	Carbon abatement millions tons	Abatement cost US$/tons of CO_2	Carbon abatement millions tons	($US million)
NZ	19.5	105.7	21.2	115.2	116.3
AUS	19.5	196.3	28.2	208.2	102.3
JPN	19.5	212.5	30.2	230.2	98.5

Table 10: Abatement costs with emission trading and no emission trading: Experiment 2

	International emission trading Abatement cost US$/tons of CO_2	No international emission trading Abatement cost US$/tons of CO_2
NZ	19.5	30.2
AUS	19.5	28.2
JPN	19.5	20.2

The last column of Table 9 showed that international emission trading is likely to be beneficial to New Zealand which has the biggest gain ($US116 million) followed by Australia ($US102.3 million) and then Japan ($US98.5 million). The abatement costs in column 3 of Table 10 showed that the marginal abatement costs is highest for New Zealand followed by Australia and Japan. International emission trading between New Zealand, the high marginal abatement cost country, with either Australia or Japan, with lower marginal abatement costs, will be beneficial for New Zealand.

6.3 Revenue Recycling

A side issue that needs to be addressed is how the potential revenue from the emission trading can be channeled back into the economy. While emissions will

incur costs on emitters, regulators will receive revenue generated by emitters' emissions. There are issues related with both the distribution of rights as well as distribution of revenues from the sale of the emission rights. These matters are important and needs further analysis, which will not be done in this paper.

7 SUMMARY AND CONCLUSION

In this paper we study the impact of both domestic emission trading and international emission trading to New Zealand. In addition, we also use the Leamer index to see if domestic emission trading or international emission trading are going to change the comparative advantage that New Zealand have.

The Leamer index for New Zealand shows that New Zealand's comparative advantage lies in energy intensive sectors such as agriculture, petrochemicals and metals such as aluminium. It is hard for New Zealand to change its comparative advantage as a result of emission trading because of the cost to the country if New Zealand will try to shift its comparative advantage from say the agricultural sector to another sector.

We also found that both domestic emission trading and international emission trading are both going to benefit New Zealand. The direction of change in the output in the emission trading was improving both in the domestic emission trading case and the international emission trading scenario. The high reduction costs sector seem to gain the most. On the other hand, the low reduction cost sectors seem to gain the least. It also evident from our simulations that both domestic and international emission trading are good for New Zealand as well as other countries trading with New Zealand.

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The Economic Effects of Climate Change Policies on New Zealand Agricultural, Forestry and Energy Sectors.

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1 INTRODUCTION

The Government released its "Preferred Climate Change Policies" in April 2002. Ratification of the Protocol will affect the New Zealand economy.

Adoption of an emissions pricing measure could cause contractions in output from emissions-intensive sectors and expansion of output from non-emissions-intensive sectors, depending on policy decisions about the sectoral coverage and application of the measure.

Modelling work by the Australian Bureau of Agricultural and Resource Economics (ABARE, 2001) for the New Zealand Ministry of Agriculture and Forestry project values for sink credits at around US$20-30 dollars a tonne of CO_2 equivalent. The models produce small declines in real GDP and increases in gross national product of between 0.05 and 0.52 percent in 2010.

Modelling work by the NZIER (2001c), on the other hand, indicate that New Zealand would face high costs in implementing any policy designed to substantially reduce CO_2 emissions on-shore. The model predicts that imports of energy intensive goods will rise, while exports of primary commodities will decline.

Both the ABARE and NZIER models suggest that ratification would result in declines in the outputs of emitting industries. Transport costs would also rise with adverse effects. The losses would be ongoing whereas receipts from the sale of emission rights in perpetuity would be ephemeral.

This paper is concerned with identifying sectoral winners and losers for a given set of climate change policies. The paper does not present primary research but uses the research of others to highlight key issues for future research.

2 THE KYOTO PROTOCOL

Scientific evidence indicates that accumulated greenhouse gas emissions from human activities are contributing to global warming. In 1993, global energy consumption was 49 percent higher than in 1973. Scenario studies predict that, over the coming decades, the use of fossil fuels will further increase by about 35 percent over current levels. According to these studies, in 2010 the annual emissions of CO_2 will have increased by 30-40 percent (van de Maesen, 2000).

If unchecked, global warming will have complex social and economic consequences. There is currently widespread belief that the effects may be sufficiently unpalatable to justify taking preventative actions.

The Kyoto Protocol represents the current attempt at devising a framework for taking such preventative action on a global scale. The Protocol was adopted by consensus at the Third Conference of the Parties (CPO3) in December 1997 but will not come into force until parties to the United Nations Framework Convention on Climate Change ratify it.

The aim of the Protocol was to reduce emissions across the developed country participants to around 5 percent below their level in 1990, as a first step towards deeper and more widespread reductions in future periods (NZIER, 2001c). International negotiations on the detailed implementation of the Kyoto Protocol have continued since 1997. The Protocol will come into force if it is ratified by 55 countries, whose combined emissions accounted for at least 55 percent of carbon dioxide emissions in 1990. If this happens, New Zealand's primary obligation will be to monitor its emissions of the six Kyoto greenhouse gases over the years 2008-2012, and ensure that on average they are equal or less than its 1990 emissions, or otherwise take responsibility for emissions above that level.

The Protocol establishes new emission targets for developed countries with individual country commitments ranging from –8% for the European Union to +10% for Iceland (Table 2.1). There is no underlying principle behind the various targets, which are only a result of political bargaining. Russia has a target of 100% of the 1990 level whereas its current emissions are 20% lower than they were in 1990. Therefore it is likely that there will be a large surplus that can be traded with the European Union and other nations.

As the agreement currently stands, most developed nations and some former communist countries, provided they each ratify the treaty, will take upon themselves a commitment to reduce their greenhouse gas emissions either to the level prevailing in 1990, or to some agreed fraction of the 1990 level by 2012. However, in practice only the developed countries will be constrained by this agreement, since the former communist countries have already seen substantial declines in their carbon emissions due to the industrial collapse suffered in the 1990s. Although signatories to the Kyoto protocol, developing countries will not face binding emission restraints in the first commitment period, 2008 to 2012, but the success of the regime critically depends on them having such obligations in subsequent commitment periods. If that does not occur, a global reduction in emissions will not be possible.

The Protocol concerns itself with net changes in greenhouse gas emissions. That is, both gross reductions in sources of emissions and increased removals by sinks are of relevance when accounting for changes in each commitment period. In the first commitment period only forest sinks created since 1990 are relevant. The definition of carbon sinks may widen under the second and subsequent commitment periods. Additional activities that may be agreed to under Article 3.4 of the Protocol include forest management for non-Kyoto forests, grazing land management, cropland management and revegetation.

It is important to note that the Protocol is a market-based mechanism to manage a global environmental risk. For developed countries, the commitment to reduce greenhouse gas emissions implies the introduction of some form of greenhouse gas charge as a means of changing the behaviour of businesses and consumers. The need to cut emissions can be offset by the production of carbon sinks, that is, afforestation and similar activities, which lock up atmospheric carbon. In addition, the Kyoto Protocol envisages a trading regime, where countries can meet their obligations by purchasing credits from other countries that have exceeded their commitments. During the 2008-2012 implementation period, such

credits will largely come from Russia, where the precipitous decline in heavy industry since 1990 has left the country with a substantial holding of excess credits.

Table 2.1 The emissions reductions for each country

Source: Scientists for Global Responsibility (1998)

Country	Change from 1990
All European countries except those listed below	-8 %
USA	-7 %
Canada, Japan, Hungary, Poland	-6 %
Croatia	-5 %
Russian Federation, Ukraine, New Zealand	0
Norway	+1 %
Australia	+8 %
Iceland	+10 %
"Annex 1" total	-5 %
Other countries	No target

- The numbers show the percentage change from 1990 levels.
- These targets apply to the average emissions for each country during the five-year period 2008-2012.
- The eastern European countries and Russia can choose a different baseline year if they wish.
- The targets apply to a basket of six greenhouse gases (CO_2, N_2O, CH_4, SF_6, HFCs, PFCs) added together using Global Warming Potentials.
- Countries may choose whether to include enhanced sinks of greenhouse gases due to land use changes (agriculture, reforestation)
- Countries listed in the table may trade emissions quotas with each other, but not with countries without targets
- Countries may gain credit for emissions reductions for projects, which they financed in other countries through the "Clean Development Mechanism" (=Joint Implementation).
- The details of the trading mechanism and accounting of sinks will be agreed at COP4 in Buenos Aires

Under the terms of the 1997 Kyoto Protocol to the 1992 United Nations Framework Convention on Climate Change, the industrialised world - known as Annex 1 countries - pledged to reduce their greenhouse (GHG) emissions to 5% below 1990 levels by the period 2008-2012. The Protocol sets out three 'flexible mechanisms', to help countries meet their obligations to cut emissions.

2.1. Flexible mechanisms

The international carbon trade can occur in three ways:

1. **Emission Trading**: Article 17 of the Kyoto Protocol allows Annex 1 countries (basically, the industrialised nations) to purchase the rights to emit greenhouse gases (GHG) from other Annex 1 countries that have reduced their GHG emissions below their assigned amounts. Trading can be carried out by intergovernmental emission trading, or inter-source trading where assigned amounts are allocated to sub-national entities

2. **Joint Implementation (JI)**: Joint implementation allows countries to claim credit for emission reductions that arise from investments in other industrialised countries. Although the credits ultimately gain their value under the Protocol from being offset against governmental commitments, this is generally envisaged as a mechanism for promoting international private sector investment in emissions-reducing projects.

3. **Clean Development Mechanism** (CDM): Article 12 allows countries (or companies) which fund projects in developing countries to get credits for certified emission reductions providing that "benefits" accrue to host country. Credits will only be allowed up to a certain level of the emission target although they accrue for the whole period (2000-2012), rather than the commitment period of 2008-2012. Under the CDM, industrialised countries will count certified emissions reductions obtained from project activities in developing countries against their agreed targets. Developing countries are intended to benefit in terms of sustainable development and to support faster access to and dissemination of clean technologies. The transfer of emission credits is not a perpetual right. Rather, it is tied to a particular project and it is temporary. Emission trading will allow one country to sell a portion of their emissions allowance to another country that can allocate companies with permits. Trade can take place between companies rather than countries.

Tradable emission permits is theoretically an attractive instrument for reducing CO_2 emission. Such permits tie the emissions to a fixed ceiling, the costs of emission reduction being as low as possible. Market access by new companies may be impeded, but in practice this will be only a marginal problem. Trading between countries (Joint Implementation) lowers the costs of emission reduction. In fact, however, it is preferable

if countries conclude explicit agreements on emission reduction targets and compensatory payments prior to permitting any inter-country trade in emission permits (Koutstaal, 1997).

3 NEW ZEALAND "PREFERRED CLIMATE CHANGE POLICIES"

The Government's preferred policy package is described in Table 3.1. The Government proposes to introduce an emissions charge from 2007 approximating the international price of emission, but capped at $25 per tonne of CO_2 equivalent, with revenue generated recycled back into the economy. All New Zealanders who use energy will be affected to a greater or lesser extent For firms where this charge may cause competitiveness concerns, it is proposed to exempt them from this charge, subject to negotiation of greenhouse agreements (NGAs) which will include a requirement that firms move towards achieving world's best practice in emissions management.

There are also specific policy measures proposed for farming and forestry sectors. For example, at least for the first commitment period, the Government will not impose a charge on methane and nitrous oxide emissions from agriculture. However, the agricultural sector is expected to significantly increase its research effort in finding solutions to reduce agricultural emissions. In forestry, the Government will retain forest sink credits and liabilities, but intends to put in place mechanisms to encourage the establishment of new forest sinks.

Table 3.1: Government's Preferred Policy Package

Pre-commitment period (2002-2008)

Negotiated Greenhouse Agreements for Competitiveness-at-risk firms

Industry/Government funded research in the agriculture sector

Projects/funding to incentivise efficient emission reduction/sink creation

Handling programme for HFCs

For SF_6 – develop solution with industry

First commitment period (2008-2012)

Introduction of an emissions charge for CO_2 approximating price of emissions, but capped at $25 per tonne of CO_2 equivalent (except for Competitiveness-at-risk)

Retain option to introduce private sector emission trading if conditions permit

Retain sink credit assets and liabilities

Negotiated Greenhouse Agreements for Competitiveness-at-risk firms

Industry/Government funded research in the agriculture sector

Projects/funding to incentivise efficient emission reduction/sink creation

Handling programme for HFCs

For SF_6 – develop solution with industry

Source: Department of the Prime Minister and Cabinet (2002)

The overall goal and key principles of New Zealand's climate change response are outlined in Table 3.2.was that New Zealand should have made significant greenhouse gas reductions on

Table 3.2: Goal and key principles of climate change policy

The Government's goal is that New Zealand should have made significant greenhouse gas reductions on business as usual and be set towards a permanent downward path for total gross emissions by 2012.

The Government has also endorsed four principles that must be met by policies introduced to meet this goal:

1. **They must result in permanent reductions in worldwide emissions over the long term.** Because the Kyoto Protocol is predicated on stabilising concentrations of greenhouse gases in the atmosphere, future commitment periods will be likely to involve deeper targets. Prudent economic risk management suggests that, although we are in an advantageous position in the first commitment period because of sink credits, we must start creating incentives for reducing emissions below 1990 levels in subsequent commitment periods.

2. **They need to be responsive to the changing international context.** This means that policies must recognise uncertainties about the future, including changes in our emissions profile, in technology and in the international environment.

3. **They need to be consistent with a growing and sustainable economy.** This means that the importance of the competitiveness of our industries (including new entrants) must be reflected in policies. Achieving this means not imposing the full cost of emissions on New Zealand industries that are considered 'Competitiveness-at-risk' and ensuring that economic opportunities in climate change are promoted.

4. **They need to be designed not to disadvantage the vulnerable in our society.** Particularly to ensure that lower socio-economic groups should not bear the burden of change.

Source: Department of the Prime Minister and Cabinet (2002)

4 DATA AND METHODOLOGY

In order to provide a meaningful comparative assessment of the economic impacts of a given set of climate change policies on the different groups within a given industrial sector, it is important to use data that were either obtained from the same database or the data that have been generated using the same model.

The data for this study are extracted from Tables 6-10 (agricultural sectors), Tables 11-12,16-17 (forestry sector) and Tables 25, 27- 30 (energy sector) of NZIER (2001c) report. These results were generated using general equilibrium models. The results are expressed

as a percentage of change from 'business as usual' (BAU). Changes in producer prices should be interpreted as real price changes, i.e. by how much the price in a given industry will rise compared to the consumer price index. For example, a 1% increase in a producer price if the CPI is also 1% would signify a 2% increase in the price of the commodity in question (NZIER, 2001c pp. 40-41).

In essence, general equilibrium models trace the effects of a shock on the economy when it settles at a new equilibrium. If the shock is a relative increase in the price of fossil energy, the new equilibrium involves all relevant behavioural responses to the new set relative prices. However, it is important to remember that the numbers produced by the NZIER (2001c) model are indicative estimates only. The scenarios examined by NZIER do not take into account policies that could offset any adverse effects of applying an emissions price.

The focus of this study is to illustrate graphically which groups within an industry sector are winners or losers for a given set of scenarios[1]. While none of the NZIER scenarios exactly replicate the Government preferred climate change polices, overall, the qualitative results of the NZIER (2001c) research pose important issues for policy makers.

5 AGRICULTURAL SECTOR

Agriculture is relatively reliant on the energy input for its continued growth. This is despite the sector enjoying one of the fastest rates of productivity improvement in the New Zealand economy. In general, future expansion of the agricultural sector is likely to be severely constrained if access to fossil fuels is limited (NZIER 2001c p.44).

The key issue for pastoral agriculture is whether the emissions regime is narrow (agricultural methane and nitrous oxide emissions not covered) or wide (NZIER, 2001c). A wide emission regime leads to drastic declines in output, employment and exports in pastoral farming (Figures 5.1-5.3) and an increase in producer prices and imports (Figures 5.4-5.6). By contrast, if only fossil fuel emissions from the sector are taxed, some growth is possible in sheep and beef farming due to the falls in the real exchange rate.

The picture for dairy farming is somewhat more complex, since it critically depends on energy intensive processing. Figures 5.1-5.3 show that output, employment and exports decline under all scenarios even if methane and nitrous oxide emissions from dairy farming are exempted from climate change policies. This is a direct result of milk processing being impacted by the high carbon charges.

[1] See Appendix 1 for the description of NZIER (2001c) ten scenarios.

The output, exports and employment of mixed farming (Figure 5.1) generally escape the negative effects as long as the agricultural emissions are exempt, although the model predicts that the returns decline

Horticulture generally benefits from the imposition of methane emission charges as farmers seek to switch land use away from pastoral farming (see Figure 5.7).

The fishing industry is the largest sector in the composite sector of the remaining primary industries. The overall effects are strongly negative (Figures 5.1-5.7), suggesting that the fishing industry will lose competitiveness.

Figure 5.1: Change in Output for Agricultural Sector

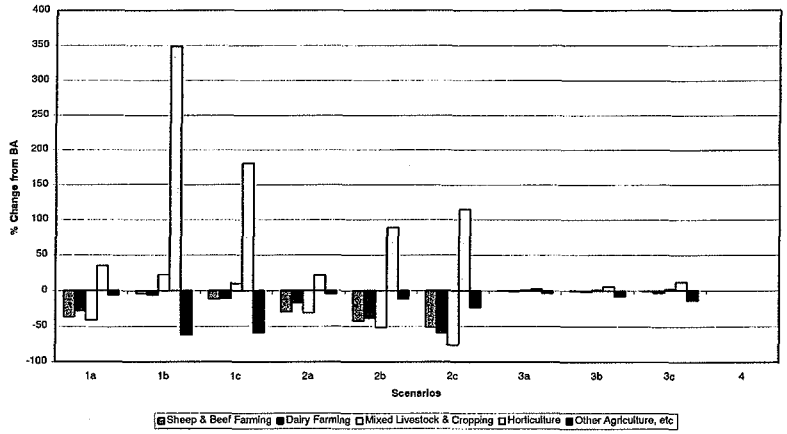


Figure 5.2: Change in Employment for Agricultural Sector

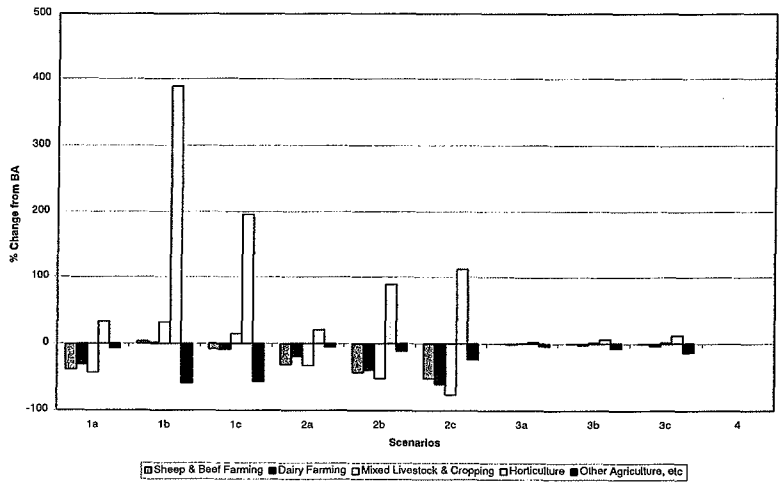
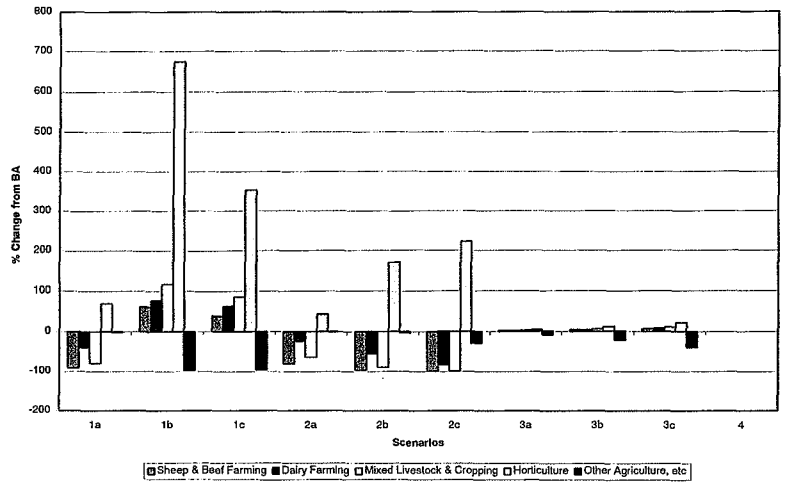


Figure 5.3: Change in Exports for Agricultural Sector



It is evident from Figures 5.1-5.7 that horticulture is the winner under all scenarios while the pastoral farming is the loser even when the methane and nitrous oxide emissions are exempted from emissions charge.

Modelling work by the Australian Bureau of Agricultural and Resource Economics (ABARE) on economic outcomes of the Kyoto Protocol for New Zealand also produced similar results. ABARE's second scenario[2] expects the international competitiveness of New

[2] **Description of ABARE's scenarios**

Scenario	Country participation			Carbon charge coverage
	USA	Australia	New Zealand	Rest of participating Annex B
1	out	in	full	full
2	out	in	full	agriculture excluded
3	out	in	agriculture excluded	agriculture excluded
4	out	out	full	full
5	out	out	full	agriculture excluded
6	out	out	agriculture excluded	agriculture excluded

Figure 5.4: Change in Imports for Agricultural Sector

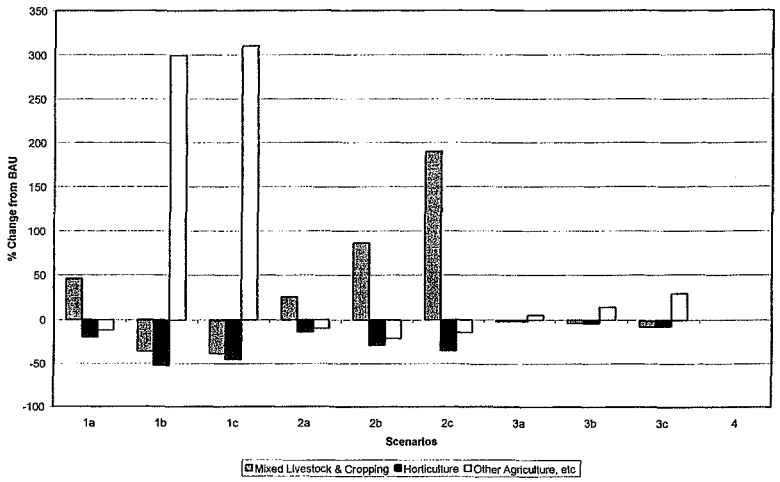


Figure 5.5: Change in Producer Price (Outputs) for Agricultural Sector

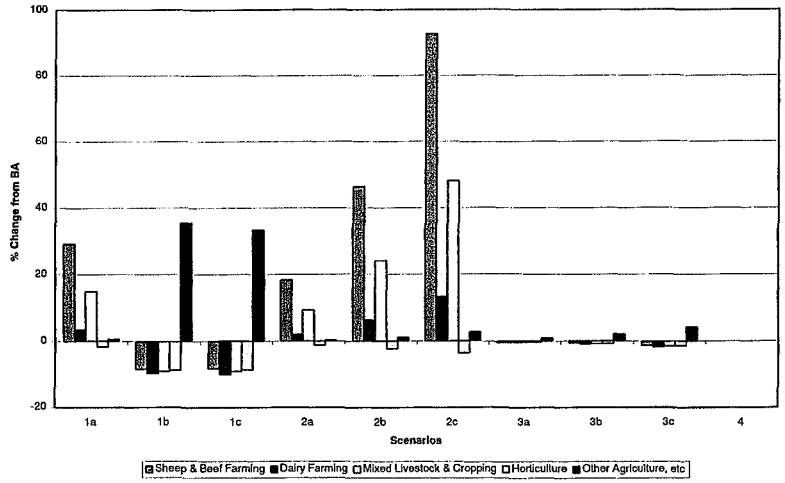
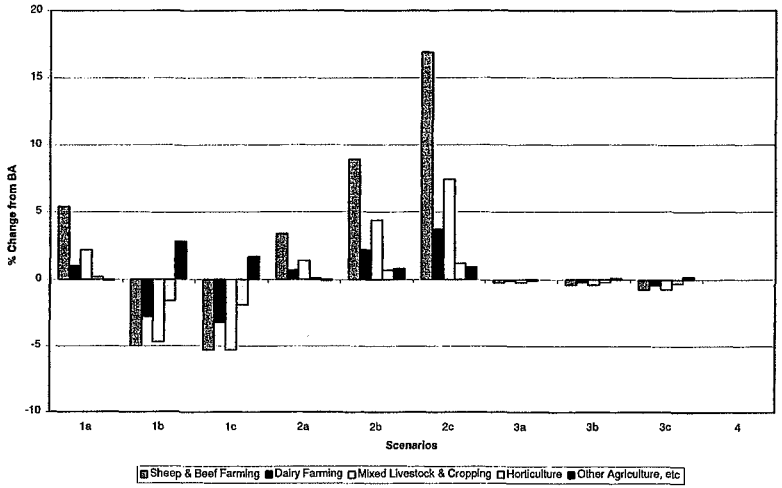


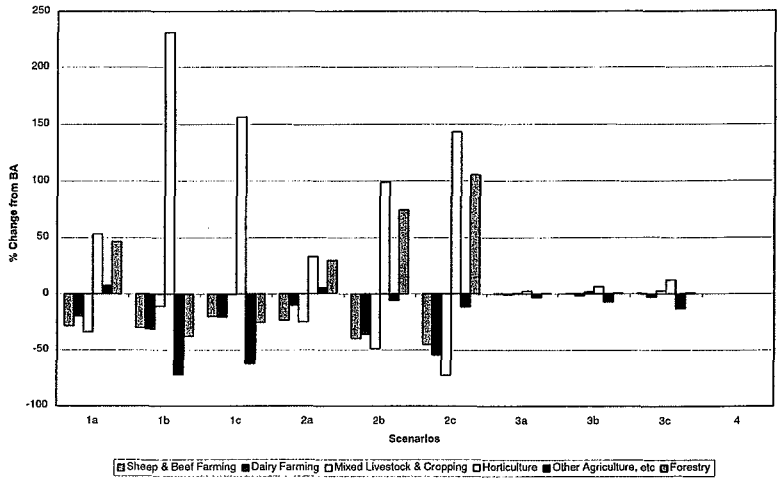
Figure 5.6: Change in Producer Price (Inputs) for Agricultural Sector



Zealand's emission-intensive agricultural industries to be significantly reduced if it is the only Annex 1 country to apply the carbon charge to methane and nitrous oxide emissions. This scenario records a 20.5 percent fall in dairy cattle outputs and a 6.8 percent decline in livestock production for meat.

This pattern is repeated in other scenarios. Forestry and crop production benefit, but they do so in conjunction with an overall fall in land values. The finding that the land values fall is significant. It suggests that these scenarios must be negative overall for agriculture.

Figure 5.7: Change in Land Use for Agricultural and Forestry Sectors



6 FORESTRY SECTOR

Forestry is a relatively energy intensive sector. However, forestry may also benefit to some extent from climate change policies due to its ability to produce carbon sinks. Modelling work by NZIER (2001c) outlined that under most scenarios[3], forestry output and employment rise (Figures 6.1-6.2). The dramatic (77.5 percent above BAU) growth predicted under scenario **2c** is essentially a function of the huge decline of pastoral agriculture, with forestry remaining one of few alternative land uses (Figure 5.7). The model predicts that the logging sector will directly follow the pattern of land use. ABARE (2001) modeling also shows an increase in forestry sector output for all of their six scenarios.

[3] See Appendix 1 for the detailed description of the scenarios used by the NZIER (2001c)

The wood processing industry is one of the relatively energy intensive sectors of the New Zealand economy. New Zealand Institute of Economics Research (2001a; 2001b) concluded that the Kyoto Protocol would result in higher transport and energy costs resulting in a loss of international competitiveness for New Zealand's wood processing industry relative to non Annex 1 countries. This is because of the fact that the New Zealand's economic structure and geography generates a greater than average dependence on road transport. The wood industry involves extensive transportation from forestry plantations spread across New Zealand to processing plants to international gateways[4] and markets. This contributes to New Zealand greater emission intensity per unit of GDP (New Zealand Institute of Economics Research, 2002).

However, Bertram (2001a, 2001b) who was commissioned by the Ministry of Agriculture and Forestry to review the NZIER's model critised the NZIER preoccupation with Chile as the comparative benchmark. Bertram stated that "The proposition that a shift in the bilateral cost relativities between New Zealand and Chile would lead to a reallocation of world capital flows such as to starve the New Zealand industry of investment funds is not compelling, given that the bulk of the world's wood processing is in higher-cost locations from which, if NZIER's hypothesis is correct, large volumes of capital ought to be flowing to both New Zealand and Chile. "

Furthermore, the Government preferred climate change policies stated that one of the key principles for future development of New Zealand's climate change policies is that the policies should avoid "carbon leakage": that is, policies will avoid high emitting industries moving their greenhouse gas emissions offshore to countries that do not have emissions reduction targets. This will protect the objectives of the Protocol pending the creation of a truly global emissions regime.

In contrast to its earlier findings, more recent modelling carried out by NZIER (2001c) predicts a fairly strong growth in the wood-processing sector (Figures 6.1-6.3). The study also found a strong relationship between the growth rate in wood supply and wood processing. A growth of 60.6 percent **(2c)** in wood output corresponds to a 46.6 percent rise in output of wood and wood products processing and a 68.1 percent rise in the output of pulp and paper processing In essence the NZIER (2001c) model predicts that only a proportion of the wood supply would be processed in New Zealand at high carbon prices.

At lower carbon prices, the sector appears to benefit from the lower exchange rates and lower labour costs, leading to export growth (NZIER 2001c p.55). The producer prices for the pulp and paper products increase when agricultural emissions are exempt (Figures 6.5-6.6).

[4] Most external trade is carried by sea: almost 85% of New Zealand's exports by value, and over 99% by volume (Statistics New Zealand). However, initially international transport itself will not be subject to the Kyoto Protocol restrictions.

Figure 6.1: Change in Output for Forestry Sector

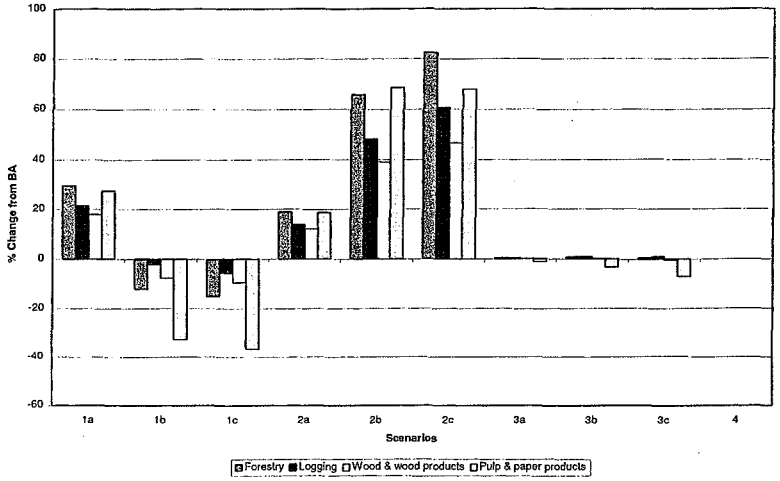


Figure 6.2: Change in Employment for Forestry Sector

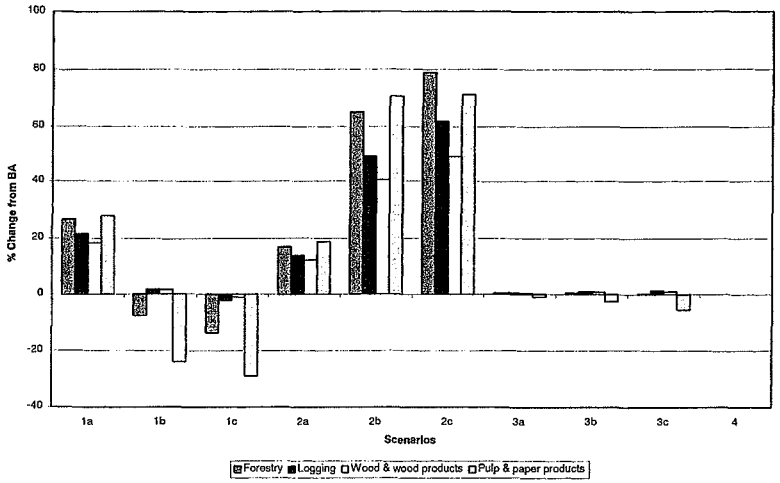


Figure 6.3: Change in Exports for Forestry Sector

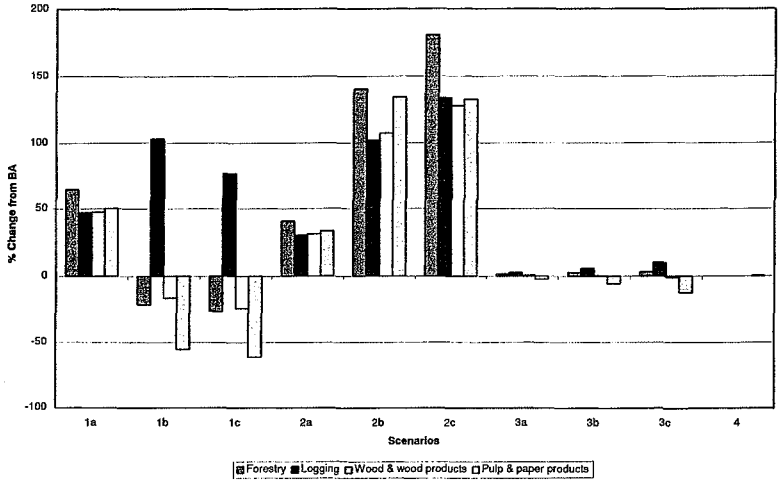


Figure 6.4: Change in Imports for Forestry Sector

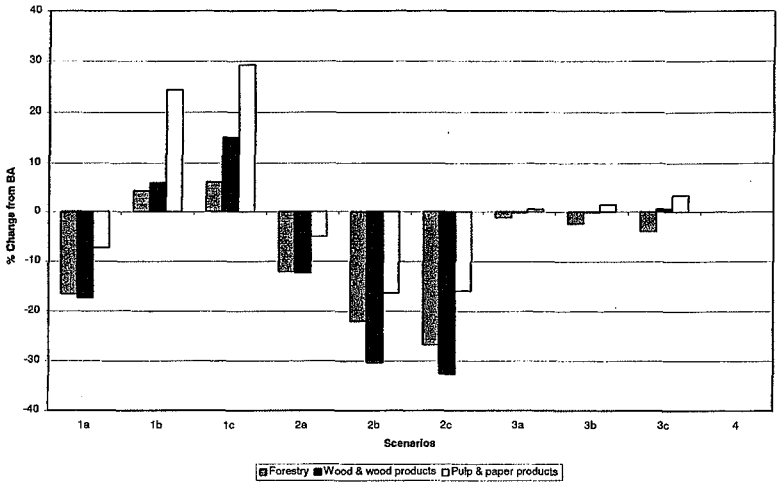


Figure 6.5: Change in Producer Price (Outputs) for Forestry Sector

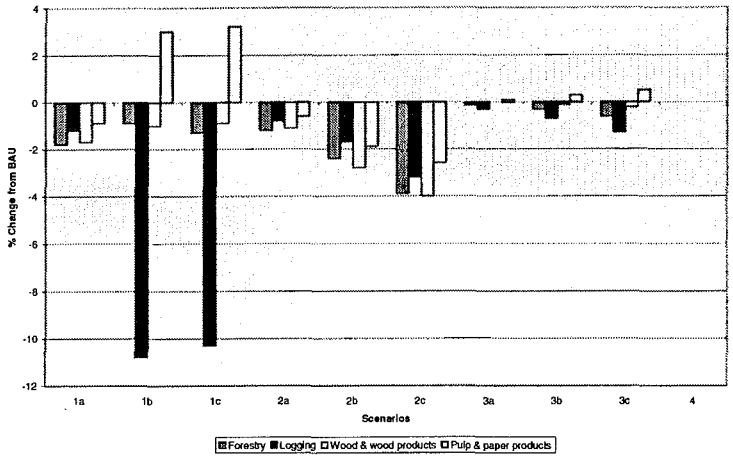
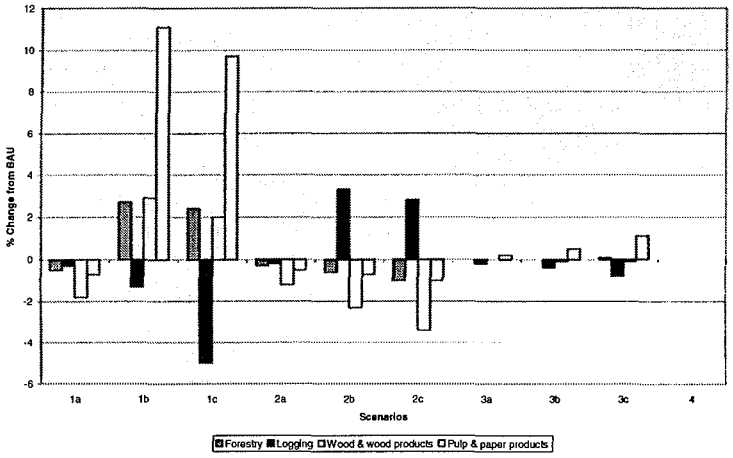


Figure 6.6: Change in Producer Price (Inputs) for Forestry Sector



8 ENERGY SECTOR

NZIER (2001c) model shows the coal sector tends to be a loser under all climate change scenarios, especially those that do not exempt cement and steel manufacturing - two key consumers of coal. Declines in output and employment are much lower under scenarios **3b** and 3c relative to **2b and 2c** (see Figures 7.1-7.2), as coal production is required to support growth in the major coal consuming sectors (primarily, growth in steel exports). As mentioned before, steel and cement sectors grow in those scenarios because they are protected from the effects of the carbon charge, but still enjoy the benefits of lower real wages and a weaker exchange rate induced by the climate change policy (NZIER 2001c p.68).

Under some of NZIER (2001c) scenarios, exports of coal increase (Figure 7.3) to offset declines in domestic consumption to some extent. However, in the absence of a stable domestic base, the overall output still declines. Coal exports decline in scenarios **1b, 2b, 2c, 3** and **4**. In the first two of these, the decline is driven primarily by a loss of competitiveness induced by higher domestic costs. In scenario **4**, the decline in exports is negligible (NZIER 2001c p.68).

The NZIER (2001c) model predicts a decline in the real price of coal under all the scenarios. It is important to note that this is the price **excluding** the carbon charge. The total cost of coal to customers, **including** the carbon charge, will rise. The underlying price of coal declines due to weaker demand, but also due to reduced labour and capital costs (Figure 7.5), which are driven down by the overall adjustment of the economy (NZIER 2001c p.68).

The oil extraction and exploration sector tends to grow under the scenarios that apply a broad emissions regime (that is, do not exempt agricultural emissions) (see Figures 7.1-7.2). This result is driven by export growth from this sector (Figure 7.3), due to the combination of declining real exchange rates and the fact that oil exports will not be subject to a carbon charge in New Zealand. By contrast, gas extraction and exploration (see Figures 7.1-7.2), declines under all scenarios due to lower domestic demand (NZIER 2001c p.71).

The producer prices for all energy sector industries rise (Figures 7.4-7.5). This means that the consumers have to pay more for their energy use.

ABARE (2001) model also shows output of coal drop significantly for all scenarios. Gas, electricity and petroleum and coal products output also decline for all of ABARE (2001) six scenarios.

Figure 7.1: Change in Output for Energy Sector

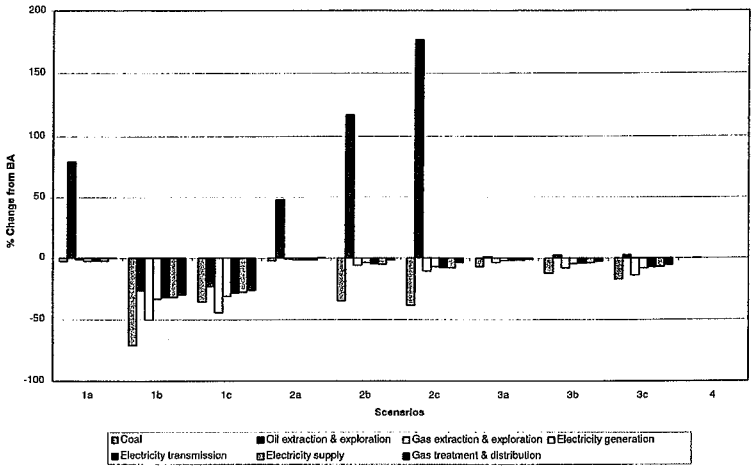
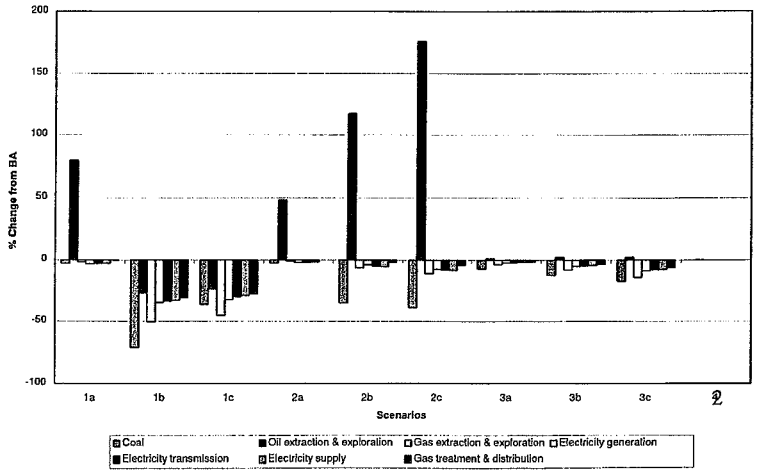


Figure 7.2: Change in Employment for Energy Sector



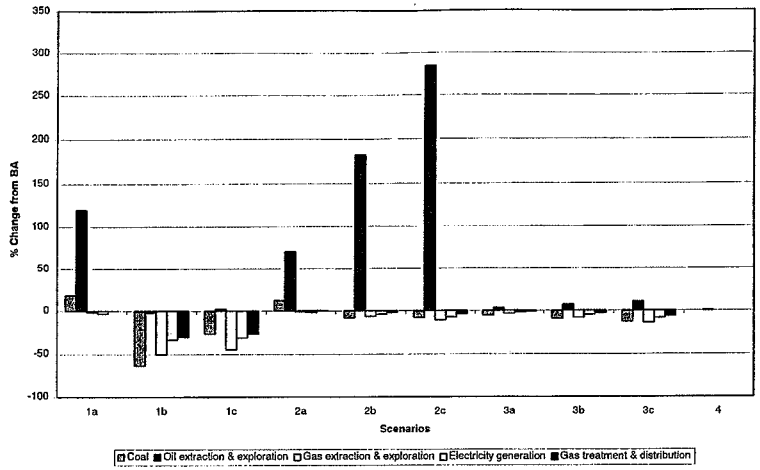


Figure 7.4: Change in Producer Price (Outputs) for Energy Sector

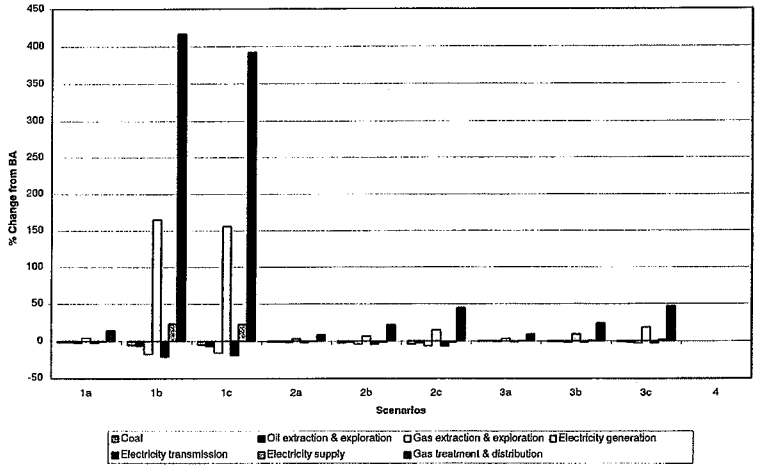
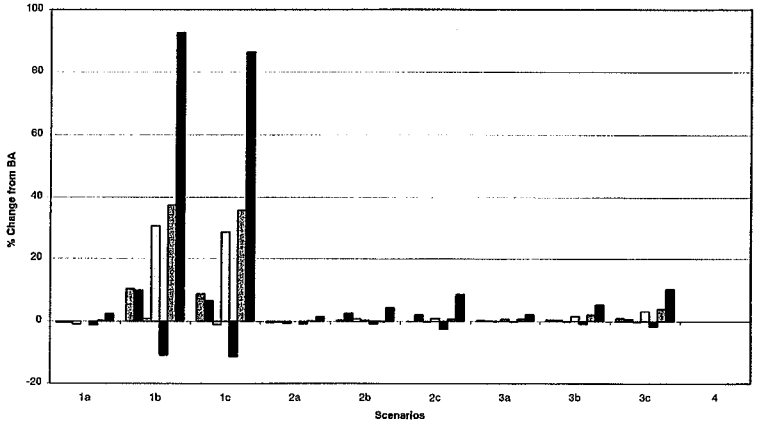


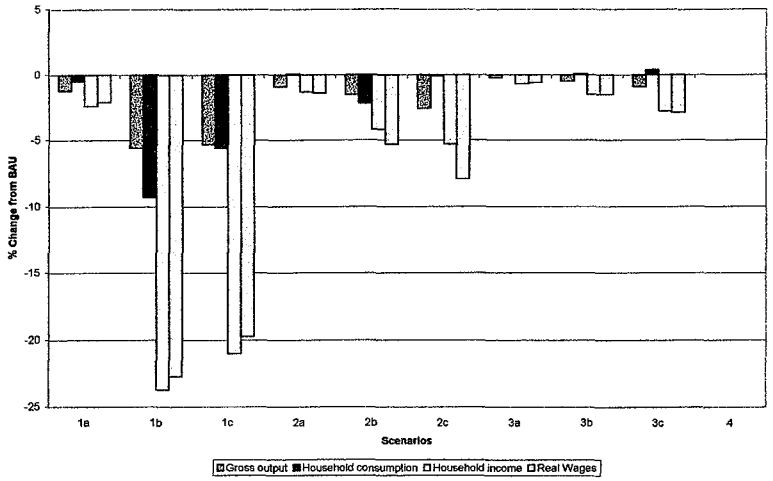
Figure 7.5: Change in Producer Price (Inputs) for Energy Sector



8 CONSUMERS

Because the carbon tax will not only impact on the price of the energy fuel the consumers used, carbon tax is also shown to have an impact on the employment in the three important sectors of New Zealand economy, Figure 8.1 shows that the consumers are losers for all the scenarios.

Figure 8.1: Change in Domestic Output, Household Consumption, Income and Real Wages



9 CONCLUSION

Under all scenarios horticulture is the winner for the agricultural sector. Pastoral farming is the loser particularly when methane and nitrous oxide emissions are not exempt. Fishing, the largest group in the composite sector is overall negatively impacted by climate change policies.

Forestry sector is a winner if agricultural emissions are not exempt but a loser if methane and nitrous oxide emissions are excluded from carbon charges.

There is an increase in land use for horticulture and forestry under all scenarios and in particular when agricultural emissions are not exempt. This is a reflection of the shift in the land use from pastoral farming into horticulture or forestry.

For the energy sector, coal is a big loser under all scenarios. Oil, on the other hand, is a winner under all scenarios and particularly when there are no exemptions.

The impact of the Government preferred climate change policies during the first commitment period will fall somewhere between the NZIER (2001c) Scenarios **3a** and **3b**. Because the agricultural emissions and the at-risks sectors are exempted from carbon tax, at least during the first commitment period, if New Zealand ratifies the Kyoto protocol the consumers and the general energy users will be the greatest losers.

However, if the agricultural sector fails to find solutions to significantly reduce the emission of methane and nitrous oxide, there is also a likelihood that the impact as portrayed by NZIER Scenarios **2a**, **2b** and **2c** could eventuate. Then the farming sector such as the dairy, sheep and beef, and other agriculture including fishing will be the losers while horticulture and forestry will be winners.

NZIER Scenarios **1a, 1b, 1c** and **4** are not likely candidates for implementation. Scenarios **1a, 1b** and **1c** where the Government collects the amount of carbon tax necessary to induce the desired reduction in emissions, and then recycles this in the form of lower taxes, would have too severe an impact on the New Zealand economy. Scenario **4** where the Government would introduce some form of broad-based tax to raise funds to purchase emission permits abroad will also be unlikely candidate. While the latter avoids the disruption and the redistribution of wealth associated with the implementation of emission abatement policies (the creation of winners/losers situation), it will not be popular because it does not penalise emitters.

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Appendix 1 : NZIER (2001c) Scenarios

NZIER (2001c) have produced ten scenarios, focusing on the following choices:

– Policies with and without international trade in emission rights.

This reflects a distinction between unilateral (early) action and participation in an international regime. The choice can be broadly described as being 'with' or 'without' Kyoto. In addition to international permit trading, two key features separate the 'with' and 'without' options.

First, under a **unilateral regime**, the New Zealand government collects the amount of carbon tax necessary to induce the desired reduction in emissions, and then recycles this in the form of lower taxes. By contrast, under an **international trading regime**, the carbon charge reflects an international permit price.

Purchases of emission permits by New Zealand entities from overseas do not represent a revenue to the New Zealand government, and hence there is no revenue to be recycled.

Second, NZIER assumes that 'with Kyoto', carbon sink production can be used to offset excess emissions.

– Narrow and broad emission regimes.

Under a **narrow emission regime**, a carbon charge is applied to emissions from energy use and from industrial processes. Under a **broad based emissions regime**, in addition to the emissions subject to the previous carbon charge, agricultural methane and nitrous oxide emissions would also require the acquisition of emission rights or receive emission credits. NZIER assumes that there is no difference in the New Zealand abatement target between the scenarios with the narrow and broad based emission regimes. Rather, NZIER assumes that the difference lies in how the policy is implemented domestically: with a narrow regime, a bigger adjustment burden is allocated to energy use, while with the broad regime; adjustment is spread between agriculture and energy.

– Exemptions for sensitive areas.

NZIER concentrates on the sectors which are most prone to 'leakage', i.e. relocation of production to countries outside the Kyoto regime. NZIER includes aluminium, cement and steel production into that category. However, other sectors may also be included, such as forest products manufacturing or methanol production.

In essence, these two issues (narrow/broad and leakage) relate to an expectation that some mechanism will be implemented to prevent the decline in 'sensitive' business

activities in New Zealand. Depending on the scenario, NZIER includes pastoral agriculture, cement, steel and aluminium production in the definition of 'sensitive' sectors.

– *The point of obligation.*

NZIER considers two broad options: the point of obligation resting with the emitting industry, and the government acting as the point of obligation for the nation as a whole.

From the above, the specific scenarios are:

1a No trade in emission credits, no exemptions, broad emission regime, obligation at point of emission.

1b No trade in emission credits, narrow emission regime (agricultural methane and nitrous oxide emissions not covered), no further exemptions, obligation at point of emission.

1c No trade in emission credits, narrow emission regime (i.e. agriculture not covered) and the steel, cement and aluminium industries exempt from emission liabilities. Under all three variants of scenario **1**, NZIER imposes an emission reduction target and configure the model to generate a carbon price that ensures that the target is reached. By contrast, under scenarios **2** and **3** below, NZIER imposes an exogenous carbon price, and observe how emissions change in response. The range of emission prices used in these scenarios has been selected to represent the range of expected prices generated by various international market models.

Hence, scenarios **2** and **3** are as follows:

2 International trade in emission credits, broad emission regime, no further exemptions, obligation at point of emission. NZIER runs three scenarios, **2a**, **2b** and **2c** with different assumed international emission permit prices: NZ$13, NZ$32.50 and NZ$65 per tonne of CO_2 equivalent (representing US$20, US$50 and US$100 per tonne of carbon, respectively).

3 International trade in emission credits, narrow emission regime, cement, steel and aluminium exempted, obligation at point of emission. Again, NZIER runs three scenarios at the three permit prices.

4 International trade in emission credits, no domestic emissions regime- government is the point of obligation. The government appropriates all carbon sink entitlements from private owners and raises a general tax to cover imports of any additional entitlements required to meet our Kyoto obligations.

Under all of the above scenarios, NZIER assumes that there is a threshold level of output reduction at which both steel and cement industries close. In both cases, if output falls by more than 20%, the model assumes that it is no longer economic to continue producing in New Zealand, and that all domestic production is replaced by imports. These threshold effects have been estimated from their studies of competitive conditions in these industries.

Border Tax Adjustment to Address Competitiveness Effects of the Kyoto Protocol

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Summary

Over the past 24 months, various industries have expressed concern about the impacts on their competitiveness of New Zealand ratifying the Kyoto Protocol. With the announcement of the government's preferred policy package at the end of April 2002, many of these concerns have been allayed, but uncertainty remains. This paper examines the potential for using border tax adjustment to address competitiveness effects of climate change measures and assesses this against measures in the government's proposed package. The paper also considers how the United States and Australia might be encouraged to re-join the global effort against climate change. Border tax adjustment is seen as a first-best measure to address competitiveness effects and as a means of encouraging the United States and Australia to join the Kyoto Protocol on terms acceptable to the other Kyoto parties.

Key words: border tax adjustment, Kyoto Protocol, competitiveness, WTO.

1 Introduction

In 1997, the Parties to the United Nations Framework Convention on Climate Change agreed to the adoption of the Kyoto Protocol. The Protocol contains commitments for developed countries that would result in an estimated 5% overall reduction in those countries' net emissions of carbon dioxide and five other greenhouse gases by 2012, compared to 1990 emissions. In July 2001, without the United States, the rest of the international community agreed to a set of rules for implementation of the Protocol. Australia has since indicated it will not ratify, either, and Canada is wavering.

Policies that governments take to reduce greenhouse gas emissions could have far-reaching and complex implications for some sectors of the economy. To reduce emissions and meet obligations under the Kyoto Protocol, governments might remove and/or increase subsidies, impose regulations, introduce carbon taxes or tradable emission permits, or negotiate directly with firms and industries. Unless governments choose to rely on subsidies, any serious attempt to reduce emissions is likely to have financial impacts on firms with substantial emissions of greenhouse gases, and on firms (such as major users of electricity) that purchase their products as inputs.

[1] The author is a private consultant. This paper is based on research performed for the Ministry of Economic Development, Wellington.

Two other effects on competitiveness, while not addressed in this report, should also be borne in mind. First, climate change itself presents serious risks to the competitiveness of New Zealand's land-based industries, especially if global emissions are not reduced substantially. Second, climate change policies in New Zealand and other countries will offer economic opportunities for firms that are ready to seize the emerging competitive advantage for substitutes for carbon-intensive products and processes, to pursue emission abatement projects in developing countries, and to implement carbon sequestration projects at home and abroad.

This paper assumes that the New Zealand government will ratify the Kyoto Protocol and accept obligations to manage its greenhouse gas emissions within an initial allocation based on 1990 level emissions. The paper discusses the concept of competitiveness and examines policy options for addressing the impacts of climate change policies on the international competitiveness of New Zealand industries and firms. Forestry issues and ownership of "sink credits" are not considered in this paper.

2 Types of competitiveness

Before one can discuss policies to address competitiveness concerns, it is important to clarify what is meant by "competitiveness". Sinner (2002) cited three general types of competitiveness that have been identified or implied in various contexts:

- **Economy-wide competitiveness** - The ability of firms across the economy to compete, via price or other product attributes, with businesses located in other countries (this is sometimes referred to as the competitiveness of a country);
- **Domestic competitiveness of firms** - The ability of specific firms or industries to compete for market share with other firms or industries in the same country;
- **International competitiveness of firms** - The ability of specific firms or industries to compete for market share with other firms or industries located in other countries, which affects the international distribution of production.

2.1 Economy-wide and domestic competitiveness

"Economy-wide competitiveness" is actually more a product of a government's macroeconomic policies than of specific sectoral or environmental policies. Indeed, some economists have argued that it makes little sense to talk about the competitiveness of an entire country or economy, and that doing so can lead to badly misguided policies (Krugman 1994). Countries do not compete the way businesses do, and a country is much more likely to be helped than harmed by the strength of its trading partners' economies. If "competitiveness" has any meaning at all for an entire economy, Krugman says, it is as a synonym for "productivity".

This is not to deny that specific policies on taxation, climate change or other matters that affect the domestic business climate do not matter, for indeed they do. But the concept of "competitiveness" is not a useful tool to examine the economy-wide implications of such policies. Rather, these issues should be considered in terms of the implications of such policies for gross domestic product (GDP) and gross

national product (GNP), alongside such issues as education levels, labour relations law, and other issues that affect productivity.

"Domestic competitiveness" may involve competition and potential substitution by consumers among broader classes of substitutes, especially in the medium to longer term. Examples include substitution between gas or wind power and coal; between different development patterns and modes of transportation in a city or region; or between waste disposal systems such as gas collection and composting of organic waste. Significantly, a loss of domestic competitiveness by one firm is the result of an increase in competitiveness of another domestic firm, i.e. the firm to which consumers have switched.

Sinner (2002) notes important differences between losses of domestic competitiveness and losses of international competitiveness. First, there is no carbon leakage to overseas countries, and hence the environmental objective is not undermined. Also, there would be inefficiencies if some domestic firms or sectors were treated differently and paid a lower cost or no cost for their emissions and as a result were able to capture market share (broadly defined) from firms that were paying full cost.

Second, the domestic adjustment process should be less painful than adjustment to losses of international competitiveness because domestic firms that have gained business would be increasing output right away and thus demanding more labour and other resources (possibly before the firms losing competitiveness lay off workers).

As long as emissions are not overpriced, changes in domestic competitiveness that result from firms being required to pay the cost of emissions are likely to improve both economic and environmental outcomes. Emissions would be reduced, and hence the overall cost of emissions to the economy would be reduced. These changes also entail adjustment costs, of course, but in general these would be outweighed by the increased efficiency in the overall economy.

2.2 International competitiveness of firms

The international competitiveness of firms is the ability of specific firms or industries to compete for market share with businesses located in other countries, which affects the location of production across countries. Put differently, it is the ability of a firm to supply product of similar quality at a similar price to other suppliers and thereby gain or hold a share of the market while maintaining profitability.

In the context of environmental policy, discussion of the international competitiveness of firms has centred on the costs of environmental measures in the producing country, and this aspect of competitiveness is the focus of this paper. A loss of competitiveness due to the costs of environmental measures can be of concern for two reasons. First, reduced international competitiveness can cause job losses and flow-on social and economic impacts in affected communities.

In the medium to longer term, workers and other resources will be employed in other sectors of the economy, if necessary through a process of currency devaluation

that makes other sectors more competitive internationally. However, this entails short-term adjustment costs on firms, workers and communities. Shareholders could see the value of their investments fall, workers might need counselling and retraining, and communities might suffer social problems associated with higher levels of unemployment and poverty.

Second, where the environmental problem crosses national boundaries, a shift in production toward countries with more lenient environmental standards could undermine the achievement of the environmental objective. With greenhouse gases (GHGs), for instance, if the cost of emissions forces a GHG-emitting production facility to close, the resulting reduction in GHG emissions may be partially or entirely offset by increased production and emissions in a country without emission obligations if there were continuing demand for the firm's output.

Developing countries do not have binding emission targets under the Kyoto Protocol, and hence are unlikely to impose carbon taxes or other emission obligations on their industries. Furthermore, some developed countries might exempt their energy-intensive industries from such measures while others do not. It therefore appears possible that for some energy-intensive industries, differences in the cost of carbon emissions could become a factor in the location of production.

If output of energy-intensive industries were to decline in countries imposing a high cost of carbon and output were to rise in low cost-of-carbon countries, this could result in a loss of jobs and assets in the high cost-of-carbon countries, with no real gain in reduced emissions. This potential phenomenon is often referred to as "carbon leakage" (see, e.g. Barrett 1995; Fisher et al 1995; Copeland and Taylor 2000), although there are other sources of carbon leakage as well (see box).

3 Is carbon leakage efficient?

After considering evidence of the likely financial impacts of carbon taxes or similar measures on businesses, Sinner (2002) concluded that:

- There are good reasons to believe that carbon charges or equivalent policies will have a substantial impact on the international competitiveness of some industries;
- In New Zealand, the industries most likely to be affected are aluminium, iron and steel manufacturing, coastal shipping, petroleum refining, cement, dairy and dairy processing, meat and wool;
- Carbon leakage caused by re-location overseas of emission-intensive industries can be efficient in terms of a country's national economic interests, even though it is generally not efficient globally.

This last conclusion rests on the assumption that mitigating adjustment costs created by decline of emission-intensive industries would be less costly than on-going subsidies to shelter such industries from the competitiveness effects of carbon charges or equivalent policies.

Sources of carbon leakage: A brief overview

Carbon leakage occurs when a decrease in greenhouse gas emissions in an Annex B* country causes an increase in emissions in a non-Annex B country. Carbon leakage is a complex phenomenon that can arise from three distinct sources:

- Lower demand for fossil fuels in Annex B countries (due to carbon taxes or equivalent measures) leads to reduced prices and therefore increased consumption of fossil fuels in non-Annex B countries;
- Carbon taxes or other measures increase the cost of energy-intensive products from Annex B countries, causing production to shift to non-Annex B countries, with corresponding increases in emissions;
- Changes in prices for fossil fuels and energy-intensive products affect terms of trade and hence incomes of non-Annex B countries – some non-Annex B countries (e.g. oil producers) will experience a loss of income and hence have lower emissions, while others will gain income and hence increase emissions as consumption rises.

This report addresses the second source of leakage – that which might arise from the relocation of production, but it should be borne in mind that this is only one component of carbon leakage.

The amount of leakage and its distribution amongst countries and industries depends on several key parameters, including:

- Business As Usual (BAU) estimates of emissions growth without carbon taxes or equivalent measures to control emissions;
- Which countries implement measures to control emissions and the sequence in which they do so;
- The supply elasticity of fossil fuel producers, especially whether OPEC reduces production to maintain prices;
- The elasticity of substitution between domestically produced and imported goods and how this is represented in the model (e.g. many of the models use what are known as Armington elasticities).

Bernstein et al (1999) reported that industries in developing countries in many cases use 3 to 4 times as much carbon per dollar value of output as do developed countries, and in some cases 10 times as much as their counterpart industries in Japan. This provides further insight into why production shifts to developing countries could result in significant increases in emissions.

* Annex B of the Kyoto Protocol lists the countries that have legally binding emission obligations.

Assuming that the government's objectives are to minimize cost to the economy and maintain environmental integrity, Sinner (2002) recommended the following criteria for government intervention to protect the international competitiveness of a firm or industry:

a. There is a substantial risk of industry output and emissions shifting to another country where producers were not subject to emission costs, *and*

b. One of the following conditions is met:

   - The adjustment costs in the industry and related communities would otherwise be greater than the future subsidies that would be required to maintain production; or
   - There were international agreement or a unilateral decision by the New Zealand government to limit "carbon leakage" in the industry in order to enhance the effectiveness and integrity of the Kyoto Protocol.

Where these criteria are not met, adjustment assistance, e.g. retraining employees, might still be warranted. This could be appropriate for firms that lose

competitiveness to domestic competitors, or firms that lose international competitiveness but do not meet other criteria for intervention to protect output.

4 Border tax adjustment and other options

There are a number of approaches governments can use to avoid loss of competitiveness and output that could otherwise result from climate change policy. These include providing adjustment assistance, full or partial exemptions from a particular policy, border tax adjustment, gratis allocations of emission permits under an emissions trading regime, and levies. In addition, project mechanisms or other forms of grants can be used to replace the financial incentives that would otherwise be provided by carbon taxes or emissions trading obligations.

Some policy options would have limited or no impacts on the competitiveness of New Zealand firms. These include the government retaining full responsibility for emissions and sink credits, project mechanisms, levies, and negotiated greenhouse agreements.

However, for many if not most sectors, these policies are not likely to satisfy the government's other criteria of efficiency and environmental integrity, for which price-based measures are better suited.

There are a number of options available for addressing the potential impacts of price-based measures on the competitiveness of firms. Where protecting output is considered important, some overseas governments have exempted selected industries from price-based climate change policies and used non-price measures instead. However, border tax adjustment and partial exemptions are usually better alternatives because they preserve incentives to reduce emissions.

Sinner (2002) provides a description and analysis of each of these options. This paper focuses on the option of border tax adjustment in comparison with measures proposed by the New Zealand government.

4.1 Border tax adjustment

Border tax adjustment (BTA) means levying carbon taxes on imported products and rebating taxes paid on exported products for the emissions that occurred during production. For an emissions trading system, BTA would mean rebating (or exempting) emission obligations on exports and applying permit obligations on imported products based on the GHG emissions during their production.

Border tax adjustment ensures that domestic industries remain internationally competitive. Exporters receive rebates of taxes paid or emission units surrendered, and hence face no disadvantage compared to overseas firms that do not have emission obligations. Producers of imported goods would have to pay for all of their emissions, and hence they would gain no advantage over domestic producers who have paid for their emissions.

BTA raises significant issues with regard to trade rules administered by the World Trade Organisation (WTO). If implemented with careful regard to those rules and to rulings in previous WTO disputes, BTA can probably be used to address many

potential competitiveness concerns for New Zealand industries. For instance, it might be necessary to define emissions trading obligations as an impost on the goods produced rather than on the emissions themselves.

Even if legally defensible, BTA could also raise concerns about the precedent it would set for the potential use of trade measures based on processes and production methods (so-called 'ppms') that are of considerable concern to many exporting nations. New Zealand would need to be able to justify its use of BTA based on the global nature of the problem and the multilateral efforts to address it, so that the door would not be left open for the use of BTA or similar measures to address local environmental concerns. This would otherwise be a major risk for New Zealand. Further analysis is required of emerging WTO jurisprudence that could support such an interpretation.

As for all of these options, the government should set threshold eligibility requirements based on the extent of price impacts an industry is likely to face from emission costs. This could be set as a fixed percentage of gross value of output (e.g. at 1% as suggested by Hoerner and Muller, 1996), or industries could be considered on a case-by-case basis. A threshold requirement reduces administrative complexity and compliance costs, and protects the environmental integrity of the scheme.

For exporters that have obligations for their own emissions, BTA is relatively straightforward once the firms meet eligibility requirements. They simply report the share of their production that was exported and apply for a rebate (or waiver) of the corresponding share of their emission units or charges. Import-competing industries could be subject to the same threshold eligibility requirements as export industries, or they could be required to show that they would not be competitive without BTA. The latter approach is probably preferred because the impacts on competitiveness will depend on where the competing products are sourced and the climate change policies of the corresponding governments.

4.2 International cooperation

Border tax adjustment could cause international tension if goods that have been taxed or otherwise charged for emissions in their original country are charged for those same emissions when the goods are imported to New Zealand. Although this would not necessarily contravene WTO rules, it would be economically inefficient as well as a source of diplomatic tension. There are two ways to avoid these disputes.

One approach is to exempt imported goods from border tax adjustment if the cost of emissions has already been paid in the country of production. While this would be relatively simple in the case of countries that have the same domestic policies as New Zealand, e.g. if both have emission trading fully exposed to international prices, disputes are still likely to arise where domestic measures differ.

Non-price measures, such as negotiated agreements or technology requirements, are clearly not equivalent to emissions trading or a carbon charge, but the appropriate level of border tax might still be disputed. And if, for instance, an exporting nation has in place a carbon tax, how does New Zealand determine whether that is

equivalent to an obligation to purchase emission units with a fluctuating international price?

A better approach, therefore, is for Kyoto participants to agree on policies for border tax adjustment. Agreement could consist of a list of industries to which BTA would be applied in both importing and exporting countries, plus an agreement to share emissions data in order to assess traded goods properly. Such an agreement would ensure that traded goods would only be charged in the importing country, and only to the extent that domestically produced goods in that country are charged. Governments would be free to apply other measures to their domestic emitters, but this would not alter the application of BTA to those emitters' goods when imported by other countries.

4.3 BTA for "indirect" emitters – the case of electricity users

One difficulty with border tax adjustment is its application to firms that are not direct emitters but that experience higher input costs due to emission charges on other firms. Electricity users are the primary example. If all electricity entailed the same emissions per kilowatt-hour, it would be a simple matter to calculate the appropriate rebate for exports and the corresponding obligation on imports. Obviously that is not the case. Different electricity generation companies emit different amounts of GHGs per kilowatt-hour, but on closer inspection this is not the key issue.

The price impact on a user of electricity is unlikely to be determined by the amount of emissions from generating the electricity the user purchases. In New Zealand, all electricity, including hydroelectricity, will increase in price by essentially the same amount, because it all competes on the same market. Given growing demand for electricity, the price increase will be determined by emission costs on the generation technology with the lowest long run marginal cost, which is likely to be gas combined-cycle turbine at least in the medium term (PA Consulting 2001).

It is also possible that buyers of gas will be able to force gas suppliers to absorb part of the cost of emissions by lowering the price of gas, especially if renewable electricity technologies like wind power are becoming competitive (ibid.). Other scenarios can also be imagined, and the situation is further complicated by the existence of long-run contracts between generators and major users.

In short, it is likely to be very difficult, even after the fact, to determine how much the price of electricity has gone up due to a new climate change policy, and how much was attributable to other factors. How then to calculate border tax adjustment?

The simple answer is to remember that the perfect is often the enemy of the good. The objective of border tax adjustment is to avoid serious competitiveness problems, not to set the economically optimal level of BTA to drive the "efficient" level of emission reduction.

Bearing in mind that any BTA rules must be compatible with New Zealand's obligations under the WTO, a sensible approach would be to use the "predominant production method" employed by the United States in assessing taxes on imported

chemicals under the Superfund Amendments and Reauthorization Act 1986 (Hoerner 1988). This methodology, which was tested by a GATT dispute panel and found to be GATT-consistent, allowed border tax adjustment based on the predominant production method in the country of production (GATT 1987).

In the context of emissions costs of electricity, this would mean assessing emission obligations on imported goods based on the average emissions associated with electricity generation in the exporting country, assuming the predominant method of producing the good in question. Importers should be allowed to provide evidence that their electricity use was lower than the "predominant method". It may be necessary to cap the potential obligation on foreign producers at no more than the equivalent charge on New Zealand producers to comply with WTO rules, although this requires further investigation.

Exports from New Zealand would be granted rebates based on a) the average emissions per kilowatt-hour for the entire country, as a proxy for the expected price increase, b) the firm's documented electricity use, and c) the firm's exports as a share of its total volume of production.

It is important to emphasize that only selected industries would be eligible for border tax adjustment. If a government attempted to apply BTA to a wide range of imports and exports, the resulting burden on the customs system would be unmanageable.

Finally, for reasons described above, it could transpire that the price of electricity will, as a result of the cost of emissions, increase considerably more than that implied by the average emissions per kilowatt-hour. If this happens, i.e. if generators are reaping windfall profits on their existing hydroelectric generation capacity, border adjustment based on average emissions would not fully offset these costs. As a result, large industrial users of electricity could still be at a competitive disadvantage relative to overseas producers.

It might be necessary in such circumstances for the government to consider imposing a tax on hydroelectric power, based on capacity at some fixed date such as 2002. All energy and emission taxes could then be border adjusted in a manner that was WTO-consistent. Because a hydro tax would capture windfall profits[2], there would be few if any economic distortions from such a tax.

4.4 Incentive effects of BTA

For import-competing firms in New Zealand, BTA preserves both competitiveness and incentives to reduce emissions. Recall that domestic firms would remain liable for their emissions (e.g. via an emissions charge or emissions trading obligations), and importers would face an equivalent obligation on their emissions. Prices in New

[2] In fact, most hydro capacity is held by state-owned enterprises, so most windfall profits are likely be "captured" by the government as dividends anyway. But to the extent that windfall profits inflate perceptions of managerial performance and distort comparisons with the performance of other energy companies, it may be preferable to capture these profits through an energy tax than via dividends to the government. Furthermore, it would probably be necessary to use an energy tax if these costs are to be adjusted at the border.

Zealand would tend to rise by the amount of the emissions charge on imported goods, and both domestic firms and importers would have an incentive to reduce their costs by cutting emissions.

In addition, the charge on imports would generate revenue for the New Zealand government.[3] Whether this would be sufficient to offset revenue that is lost from BTA rebates for exports (or provide sufficient emission units to account for those emissions) would depend on the import vs. export balance of industries determined to be eligible for BTA and the extent to which emissions from export sectors are increasing relative to 1990 emissions.

For exported goods receiving BTA rebates, the only incentive to reduce emissions would stem from emissions obligations, if any, levied by the importing country. This could work reasonably well for firms that export primarily to countries that have BTA similar to New Zealand, e.g. under a cooperation agreement as suggested in section 3.5. But for BTA-eligible firms that are exporting a significant amount of product to countries not imposing emission obligations on imports, the incentive to reduce emissions is weakened and possibly non-existent. New Zealand's agriculture sector is in this position, because no other country has shown an inclination to impose emission obligations on its farming sector.

If exporting sectors have significant emissions, have increased emissions significantly since 1990, or have the prospect of increasing emissions, then exempting them from emission obligations might not be good public policy. As discussed above, this could effectively require an on-going subsidy from taxpayers to keep these exporters competitive internationally.

Thus, a different approach might be warranted for exporting firms or entire industries whose competitiveness is determined to be at risk but that are unlikely to face emission incentives from importing countries. The ideal approach would protect competitiveness while providing incentives to reduce emissions, without creating additional financial obligations on the government. No such perfect solution is likely to exist, but options include gratis allocation or partial exemptions from emissions trading or charges, project-based trading with levies, and non-price instruments such as research, extension and negotiated agreements. These are discussed below.

5 Analysis

5.1 The Government's "preferred policy package"

On 30 April 2002, the New Zealand government released its "preferred policy package" for implementing its Kyoto commitments. Prior to 2008, the government said it would rely on a number of "foundation policies". These include an energy efficiency strategy with a target for electricity generated by renewable sources, an

[3] Under an emissions trading system, the importer would be required to surrender emission units to the New Zealand government for emissions that occurred in the country of production. Since New Zealand is not responsible for reporting those emissions to the FCCC, it can sell any permits received from importers. Or, it could use them to account for emissions from the production of goods that were exported and received BTA rebates.

expected new transport strategy and a strategy targeting solid waste management. For the first commitment period of 2008 - 2012, the government proposed to implement a charge on CO_2 emissions from 2007 or 2008. This charge will approximate the international price of CO_2 emission units but will be capped at NZ$25/tonne. The government said it would retain the option of introducing emissions trading as an alternative to an emissions charge if the international carbon market is functional and the price is reliably below the $NZ25 cap (NZCCP, 2002).

The government announced special policies for agriculture and other "competitiveness at risk" industries, effectively exempting them from the emissions charge but with conditions attached. These policies are discussed in more detail below. In addition, the government said it would offer financial incentives for projects that would deliver defined reductions in greenhouse gas emissions, based on competitive bids from any sector of the economy. To qualify, projects must be additional to business-as-usual.

The government also announced that it intended to retain, at least for the first commitment period, the sink credits and associated liabilities allocated to New Zealand under the Protocol for post-1990 forest plantings. As with emissions charges, revenue from the sale of sink credits will be used to fund projects and to cover emissions from sheltered sectors, with the excess recycled back into the economy via reductions in taxes.

Non-CO_2 emissions from waste would be managed under the government's waste strategy, without an explicit charge for greenhouse gas emissions. Emissions of synthetic gases (e.g. HFCs used in refrigeration and electrical equipment) would be managed by regulatory handling requirements, the government indicated, while it wished to work with industry to find ways to manage SF_6 emissions, which originate primarily from aluminium smelting.

5.2 Measures for "competitiveness at risk" industries

The government indicated that it would offer "negotiated greenhouse agreements for sectors and industries that would face difficulty in adjusting to a full price on emissions in the first commitment period. These sectors and industries are identified as having their competitiveness at risk. Negotiated Greenhouse Agreements (NGAs) would comprise a contractual commitment by the industry or sector to achieve international best practice in managing emissions, in return for exemption from an emissions charge" (Hodgson, 2002).

While this policy is likely to address the competitiveness concerns of major emission-intensive industries, it is not without difficulties:

- **Large numbers of firms** are likely to seek NGAs, with implications for the government's ability to negotiate and manage the process in a timely, consistent and efficient manner;
- There will be significant **information asymmetries**, in that company officials will control information on what the firm can technically and financially afford to do, while government officials will have to determine "international best practice" that will be difficult to match with circumstances of New Zealand firms;
- It remains **unclear how the policy will protect industrial electricity users** from the higher costs of electricity (the price of hydro and other renewable energy is likely to increase as markets adjust to the higher cost of generating electricity from fossil fuels);
- Once the NGA is negotiated, there will be **limited incentive for firms to reduce their emissions** beyond the agreed target except with government funding under the project mechanism;
- If targets were expressed as emissions per unit of output, as firms are likely to seek, the **government would be exposed to financial risk** due to increased production.

As a result of these problems, this policy could involve significant administrative costs for the government with only modest reductions in emissions agreed and implemented by industry. The government would probably end up paying for additional reductions through the project mechanism, and would pay for agreed emissions in excess of 1990 baselines, which could increase substantially depending on how targets are expressed.

At least in principle, a policy of border tax adjustment (BTA) for import-competing industries and partial exemption from emission charges for export industries would be more efficient. Import-competing industries for which emissions charges constituted more than 1% of gross revenue (as suggested by Hoerner and Muller, 1996) could be deemed eligible for BTA, meaning that all imported goods would be taxed. In New Zealand, the iron and steel and cement industries would meet this test, along with possibly a few others.

BTA would protect the competitive position of New Zealand firms while maintaining their incentives to reduce emissions, and it would raise revenue rather than impose costs on taxpayers. There would be no need to negotiate industry- or firm-specific emission reductions. As noted in section 4.1, this approach would raise significant issues with regard to New Zealand's obligations under trade agreements administered by the World Trade Organisation (WTO). These issues are discussed further below.

For export industries, BTA is also possible but would remove incentives for emission reductions and leave the government exposed to considerable financial risk from the potential for increased output and emissions. Hence a preferred approach is to give eligible exporting firms, e.g. those for whom emissions charges would otherwise constitute more than 1% of gross revenue, a partial exemption from those emission charges. The exemption would be equal to emissions at some baseline level of output, and any emissions above that level would be subject to the standard emissions charge. As an option, the government could subtract from the exemption an amount equal to 1% of gross revenue. By reducing the significance of being just above or just below the 1% cut-off, this would reduce the pressure to determine industries near the threshold to be eligible.

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If each firm's or industry's level of emissions exempted from the charge were left as a matter for negotiation, this approach would be similar to using NGAs for exporting firms, except that the "penalty" for exceeding the target would be known in advance and administered through the carbon charge system without further ado. To simplify matters further, the government could exempt emissions equivalent to those in a specified year rather than entering negotiations with each industry.

If the government moved from a carbon charge to an emissions trading regime, then the partial exemptions would be converted to a gratis allocation of emission units. This has the added advantages of encouraging firms to reducing emissions below their baseline amount, because they would be able to sell any excess units, and freeing the government from the risk associated with movements in the price of emissions units.

As for BTA, however, exemptions and allocations of emission units raise issues of compliance with WTO rules. These are discussed further below.

5.3 Measures for agriculture

Government officials have forecast that during the first commitment period, agricultural emissions will exceed 1990 levels by about 25 million tonnes of CO_2 equivalent. It would cost New Zealand an estimated $625 million (at NZ$25 per tonne) to purchase this amount of emissions units to meet its Kyoto obligations, or to forego sale of an equivalent amount of sink credits (NZCCP 2002).

The government announced that it would exempt on-farm agricultural emissions of methane and nitrous oxide from any price measure (emissions charge or trading regime) in the first commitment period. Carbon dioxide emissions from electricity use and fuel combustion would still be subject to the carbon charge. This policy is contingent upon research investment from the sector, in partnership with the government, to identify options for reducing agricultural emissions. The government retained the option of imposing a research levy if the sector's research investment is judged inadequate.

The government anticipated that if practical solutions emerge from research and offer productivity or other benefits in addition to reducing greenhouse gas emissions, farmers might willingly adopt them. If research results were not adopted for commercial reasons, then the project mechanism (i.e. financial incentives from a contestable fund) might be used to encourage uptake during the first commitment period (NZCCP 2002).

Despite getting the most generous treatment of any sector, the agricultural sector has complained about being forced to invest in research and about the uncertainty surrounding future commitment periods. In fact, the policy towards agriculture is arguably too generous, and would create inequities:

- Sheep farmers and farm foresters (many farmers are both) get no credit for reductions in emissions and trees planted since 1990;

- There are no direct incentives for those sectors with increasing emissions (primarily dairy and deer) to contain their growth or intensify their search for emission-reducing technologies; and
- The government will be required to pay for agriculture's excess emissions, an estimated $625 million over five years. Although this can be funded out of sink credits retained by the government, it still represents a cost to New Zealand.

An alternative approach would have been to treat agriculture much like other "competitive at risk" industries as suggested above. That is, the sector as a whole, or each sub-sector, could be given a baseline level of emissions set based on 1990 or some other year. This level of emissions would be exempt from the emissions charge or, under an emission trading regime, could be converted to a gratis allocation, and the agricultural sector would be responsible for any emissions in excess of this amount.

This approach would create strong incentives for the agricultural sector to invest in research, although given the nature of the sector some organisations with levy powers might need to be established. Even under the government's proposal, however, one or more new organisations might be necessary to fund, purchase and oversee the anticipated research, and this could well require levy powers if sufficient funding is not forthcoming from the sector. As well as funding research, money raised via levies or otherwise could be used to fund technology adoption if necessary, since there is no particular reason the government should pay for this through the project mechanism.

This alternative approach would make it difficult for the dairy sector, in particular, to grow, and globally this could result in increased demand for dairy products being captured by competitors. Given that no other country is likely to impose greenhouse gas obligations on its dairy farmers, this would probably constitute carbon leakage. Nonetheless, it is the efficient approach for New Zealand, recalling that ever since the mid-1980s the New Zealand government decided not to subsidize agricultural production just because other governments subsidize their farmers. And realising that its growth was constrained by its emissions would be yet another incentive for the agricultural sector to invest in research and extension.

5.4 Measures for 'not at risk' sectors

As noted above, the government has proposed that carbon dioxide emissions in the rest of the economy would be subject to an emissions charge capped at NZ$25/tonne of CO_2 equivalent. It has also said it will offer contestable funding for projects that deliver defined reductions in greenhouse gas emissions, as long as they reductions are additional to business-as-usual, i.e. would not have occurred in the absence of project funding. Revenue raised through the emissions charge would be used to fund projects and other climate change initiatives, with the remained recycled via reductions in other taxes.

One could argue that sectors whose international competitiveness is "not at risk" should bear the full price of emissions in order to ensure efficient adoption of emission abatement practices. However, because the international price of emissions for the period 2008-2012 is unknown, it cannot be known with any

certainty what industries will be at risk. Price uncertainty also makes it difficult for New Zealand businesses to plan for the future, e.g. to determine the return to proposed investments.

Thus, capping the price helps to manage the demand for NGAs and provides increased certainty to business, both of which should help to ease the transition to an economy with a cost on greenhouse gas emissions. In particular, capping the emissions charge means that if the international price of emissions is very high during the first commitment period, there would be only limited disruption to the New Zealand economy as the government would effectively cover the difference between the international price and the capped domestic price. It should be noted, however, that this would in effect be a subsidy to New Zealand emitters, though it would probably not be defined as such by WTO rules.

For those industries on the margin of being "competitive at risk" it will be difficult for the government and its advisors to decide whether to grant eligibility for an NGA or to impose the carbon charge. Making all firms subject to the emissions charge for up to 1% of their gross revenues, as suggested above for "at risk" industries, would make this a non-issue for most industries, according to Hoerner and Muller (1996).

5.5 Climate change policies and the WTO

As mentioned previously, the WTO consistency of some of the measures recommended in this paper needs to be investigated. This in particular applies to border tax adjustment, given that BTA would involve assessing a tax or emissions trading obligation on imports based on greenhouse gases emitted during production in a foreign country. There is some GATT jurisprudence that suggests that costs can be assessed on imports based on their production method (GATT 1987, Hoerner 1988), but whether this can be extended to an obligation on emissions is not clear.

Further important questions include whether, or under what conditions, gratis allocations of emission units would be consistent with WTO rules, in particular the Subsidies Agreement, and the consistency with that agreement of direct subsidies and tax credits for climate policy purposes. Some clarification of these matters is required.

For all of these WTO questions, consideration must be given not only to whether a proposed measure would be consistent with the basic obligations of the WTO Agreements, but also whether, if challenged, measures could be justified under the Article XX(b) or XX(g) exceptions in the General Agreement on Tariffs and Trade 1994.

Discussions between Kyoto parties should be held regarding coordination of border tax adjustment for specific industries, and regarding interpretations of WTO rules relevant to the implementation of the Protocol. These discussions should aim for a formal agreement on BTA and on sharing of emissions data for an agreed list of industries.

Particular consideration needs to be given to the application of trade measures to two groups of countries: developing countries, and developed countries that have opted not to ratify the Kyoto Protocol.

Although developing countries do not have binding emission targets in the Protocol's first commitment period, many of them are taking serious steps to constrain emissions growth. The world's poorest countries are among those most at risk from climate change, and hence are anxious to see the Kyoto Protocol implemented in an effective manner. But they are also concerned more generally that developed countries will use environmental measures as the newest excuse to restrict their access to developed country markets.

One of the many challenges of the Kyoto Protocol is to find ways to combat climate change while protecting the competitiveness of developed countries' industries and, at the same time, improving the access of the people of developing countries to the markets of the world's wealthier nations.

6 Re-engaging the United States and Australia

Trade measures may also have a role to play in encouraging the United States and Australia to re-join the concerted international effort to address the challenge of climate change.

6.1 Scenarios for re-engagement

There are several possible scenarios regarding how countries that do not ratify the Kyoto Protocol might coordinate their policies with Kyoto parties. These include the non-ratifying countries staying outside but participating in a single market for emission permits, operating parallel markets for emission permits with possibly different prices prevailing, or joining the Kyoto Protocol for the second or subsequent commitment period. Another scenario is for non-ratifying parties to continue with voluntary measures and impose no price on their emissions at all.

A scenario with parallel markets and different prices would clearly be inefficient, would probably evolve into a single market over time. A single market would be efficient in the sense that all emissions would face the same marginal cost, but would leave two or more separate processes for determining the "supply" of emission units, i.e. the binding targets that would apply to emissions. Kyoto parties would continue to determine their targets jointly through negotiations, while non-Kyoto parties might develop their own collective process, set their targets unilaterally, or set no targets at all.

Whatever process (if any) the non-Kyoto parties adopt to set emission targets, there is a substantial risk that they will "free-ride" on the emission reduction policies of the Kyoto parties. Free-riding does not necessarily generate inefficiency as long as there is a single price for emissions, but it raises two significant problems.

First, if Kyoto parties perceive other countries to be free-riding, especially if this includes the country that emits a quarter of the world's greenhouse gases, they will be reluctant to take on the significant further reductions in emissions that are likely to be required to reduce the severity of climate change. Though it will be impossible to determine what is an efficient level of emission reduction, it can be said with some confidence that free-riding behaviour by some of the largest per capita emitters will make it more difficult to achieve that level of reduction whatever it may be.

Foreign aid to America?

Second, there is the simple matter of fairness. Greenhouse gas emissions in the United States are already 12% over 1990 levels and 20% over the target the US agreed to in the Kyoto Protocol but has since rejected. Projections from the USEPA indicate that by 2010, the middle of the first Kyoto commitment period, US emissions are likely to be between 22% and 37% over 1990, and between 31% and 47% over the US Kyoto target (Pew Center, 2001). When valued at NZ$25/tonne of CO_2 equivalent, this excess over Kyoto commitments is worth between NZ$12 billion and NZ$18 billion, or about US$5 billion to US$7 billion, *per year*.

Kyoto parties would need to take on more stringent emission reductions in order to achieve the reduction in emissions that would have been achieved had the United States met its original target. This would represent an annual transfer from Kyoto parties to the United States roughly equivalent to the entire US development assistance budget[4], *every year*, for as long as the US refuses to align its reduction commitments with those of the original Kyoto parties.

Carrots or sticks?

What are the chances that the United States will in fact meet its original target, or at least pay for the difference? Of the scenarios described above for co-ordination of policies, none is likely to involve the United States (or Australia) committing to meet its original target. By holding out, they have gained the bargaining advantage, and the Kyoto parties will need to offer carrots or sticks to get them to rejoin the international effort to reduce emissions.

The "carrot scenario" could entail the United States and Australia being invited to participate in negotiations, due to start in 2005, on targets for the second commitment period. There is general acknowledgement that the pace of global warming is going to require further reductions in emissions, possibly larger reductions than in the first commitment period. This would probably imply reductions of a further 5-10% for developed countries. Would the United States and Australia willingly accept a reduction commitment based on their 1990 emissions, when they could continue free-riding?

6.2 The essential bargain?

If, as seems more likely, the US and Australia will only accept targets based on emissions in 2008 or 2012, should the rest of the world accept this "bargain" as a necessary price of getting the United States and Australia to re-engage in the Kyoto Protocol? Or should pressure be brought to bear on those countries to accept their proper share of the burden? Pressure could take a variety of forms, of course, but one obvious option is for Kyoto parties to use border tax adjustment and related trade measures against US exports, in effect obliging them to pay for the emissions from production of those goods.

[4] According to the website of the United States Agency for International Development (www.usaid.gov), the proposed foreign aid budget for 2003 totals US$8.5 billion, of which nearly $2 billion is aid to Israel, Egypt and Ireland to promote US strategic interests.

This would be consistent with sound economic policy and it would help to reduce carbon leakage from the Kyoto parties, but it would be sure to cause a tremendous row at the WTO. It would therefore be essential for the Kyoto parties to have a formal agreed approach. Recent WTO jurisprudence suggests that the Kyoto position could well be upheld, but this might still not settle the matter, as evidenced by the on-going WTO dispute between the US and European Union over the use of hormones in beef production. Whether New Zealand and the other Kyoto parties want to play for such stakes is a difficult question, but it seems there may only be two alternatives: continue to give, collectively, US$5 billion or more to Americans every year, or accept much slower action in reducing emissions and therefore greater warming of the earth's climate.

Thus, it is all the more important to sort out WTO issues: to enable the implementation of first-best domestic policies, and to get the US and Australia to re-engage on equitable terms, i.e. without rewarding their free-riding behaviour. This is important not just for climate change, but for any future problem that requires multi-lateral cooperation.

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Greenhouse Gas Emissions from Livestock – Testing the Importance of Emission Factors.

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The Lincoln Trade and Environment Model has been modified to include greenhouse gas emissions from the dairy, beef and veal, and sheep sectors. These emissions are converted to carbon dioxide equivalents through an equation linking methane and nitrous oxide. The calculation of the gases in dependant on emission factors, which are either given by the IPCC or more accurate ones developed through research. This paper presents results from three scenarios using different emission factors. Although the results show only small changes in total emissions across the scenarios, the importance of obtaining more accurate factors is evident.

Introduction

The LTEM (Lincoln Trade and Environment Model) has been used to analyse various trade policy changes and their subsequent impacts on agricultural sectors around the world. It was previously modified to include the environmental indicator of groundwater nitrates, and the introduction of three separate production systems in four main countries in the model. Modelling scenarios have included changes in trade policy and the effect on groundwater nitrate production from the dairy sector (Saunders et al 2000), and the impacts of changes in agricultural policy in the EU on greenhouse gas emissions from the dairy sector (Saunders et al 2002). Recently the LTEM was further enhanced to include greenhouse gas emissions from the beef and sheep sectors as well as the dairy sector.

The LTEM is therefore now able to project levels of emissions of the greenhouse gases (GHGs) methane (CH_4), and nitrous oxide (N_2O), converted to carbon dioxide (CO_2) equivalents from world livestock production, to 2010. The purpose of this paper is to project greenhouse gas emissions out to 2010, using different emission factors across the four main countries of interest to New Zealand: New Zealand, Australia, the EU and the United States. Previously, greenhouse gas emissions have been presented from this model using default emission factors for all countries except New Zealand, and more accurate figures for New Zealand. This paper will illustrate the effect on greenhouse gas emissions, of using default figures for New Zealand, and in further scenarios, of using more accurate figures for other countries in addition to New Zealand.

This paper will also briefly outline the importance to New Zealand of changes in GHG emissions, describe the LTEM in more detail and provide the emission results from the LTEM of the three scenarios.

Background

Climate change and greenhouse gas emissions from agriculture

In response to the threat of serious changes to the world's climate, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992. The objective of the UNFCCC is to achieve 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. The convention embraces the precautionary principle, in that it promotes action despite scientific uncertainty as to the likely magnitude and impacts of climate change.

The third Conference of the Parties to the UNFCCC held in Kyoto, Japan in 1997 resulted in an agreement known as the Kyoto Protocol. In this protocol, developed countries agreed to reduce their collective greenhouse gas emissions to at least five percent below 1990 levels, averaged over the period 2008-2012.

The Kyoto Protocol will become legally binding when at least 55 countries, representing 55 percent of developed countries' carbon dioxide (CO_2) emissions, have signed and ratified the protocol. New Zealand recently indicated its intent to ratify the protocol, although the US and Australia have stated they will not be ratifying it, casting some doubt on the future and effectiveness of the protocol. However, one can assume that there will be some form of international agreement to reduce greenhouse gas emissions.

The issue of climate change is of particular importance in New Zealand, on a variety of levels. Being an island nation based predominantly on agriculture, increases in sea level and changes in temperature will have significant effects on some regions and types of agriculture. Furthermore, in New Zealand, approximately 55 percent of greenhouse gas emissions come from agriculture, and thus agriculture will be an area where some emission reductions must occur. While New Zealand supports the reduction of greenhouse gases, any policy designed to limit emissions is likely to have a significant impact on the country's agriculture.

The link between agriculture and climate change

Agriculture is both an emitter and a sink of greenhouse gases. The primary gases produced from agriculture are methane and nitrous oxide. Both these gases have higher global warming potentials than carbon dioxide (CO_2). Using CO_2 as a base (ie.1), methane has a global warming potential of 21, and nitrous oxide 310 (MfE 1999). The sources of these gases in the context of this paper include:

- Enteric fermentation
- Manure management
- Agricultural soils

Emissions of methane or nitrous oxide from arable agriculture are not considered here.

Emission factors

Emission factors are important in determining the total greenhouse gas emissions in each country. The IPCC in its guidelines produces default emission factors for the different sources of gases, for a maximum of eight regions of the world (North America, Western Europe, Eastern Europe, Oceania, Latin America, Asia, Africa and Middle East, and the Indian Subcontinent). Naturally therefore, these values will vary considerably within each region and New Zealand, as have many other countries, has carried out in-depth research to provide more accurate emission factors. The choice of emission factor is important in determining the total emissions, and therefore accurate emission factors are vital. Emission factors are implicit in the variable coefficients in the LTEM, and the values are provided by soil scientists at Lincoln University (Clough and Sherlock, 2001). In previous papers using this model, the emission factors used for all countries except New Zealand were default values provided by the IPCC. This paper attempts to determine the sensitivity of the model to different emission factors, therefore three different scenarios will be tested, using different emission factors in each.

The Empirical Model: LTEM

There are two main economic modeling approaches used to model international trade with a focus on the agricultural sector and in various contexts. These are the economy-wide general equilibrium (GE) and partial-economy partial equilibrium (PE) frameworks. The choice of PE and GE framework depends mostly on the specific purposes of the modeling exercise. Both frameworks have advantages in different contexts, simulations in both frameworks may be biased and their robustness may be questioned, as further explained in Laird and Yeats (1992) and Harrison et al. (1993). Policy analysts tend to prefer PE frameworks in quantifying the effects of agricultural and trade policy measures based on factors such as the level of commodity disaggregation, ease of tracability of the interactions and transparency of the results, the relatively small size of the models and the number of behavioural parameters and the methods used to obtain those parameters (Francois and Hall, 1997; Roningen, 1997; Gaisford and Kerr, 2000; Beers and Bergh, 1996). In addition, the ability to include agricultural input markets endogenously and to treat commodities as imperfect substitutes (in other words to include bilateral trade relationships) with some effort may make PE frameworks more attractive.

In this research a PE model, the LTEM is preferred primarily because of the level of commodity disaggregation that is possible. The problem of data and parameter availability or calibration problems which arise as one of the main problems at this level of disaggregation in GE models is avoided in this way. This is also the major advantage of the LTEM is that it enables impacts to be modelled to the level of the production system.

The LTEM is an agricultural multi-country, multi-commodity model based upon VORSIM,[1] which evolved from SWOPSIM and associated trade-databases used to conduct analyses during the Uruguay Round (Roningen, 1986; Roningen et al., 1991). The LTEM is extended to quantify the linkages between the agricultural sector and the environment in various contexts by modifying the main model structure to include environmental sub-modules or environmental damage functions[2].

General features of the LTEM

The LTEM includes 19 agricultural (7 crop and 12 livestock products) commodities and 17 countries. The linkages of the agricultural sector with the other industries and factor markets are not considered. The commodities included in the model are treated as homogeneous with respect to the country of origin and destination and to the physical characteristics of the product. Therefore commodities are perfect substitutes in consumption in international markets. Importers and exporters are assumed to be indifferent about their trade partners. Based on these assumptions, the model is built as a non-spatial type, which emphasizes the net trade of commodities in each region. However, the supply and demand shares of countries in trade can be traced down.

The LTEM is a synthetic model since the parameters are adopted from the literature. The interdependencies between primary and processed products and/or between substitutes are reflected by cross-price elasticities which reflect the symmetry condition[3]. Therefore own- and cross-price elasticities are consistent with the theory. The model is used to quantify the price, supply, demand and net trade effects of various policy changes. The economic welfare implications of policy changes are also calculated in the LTEM using the producer and consumer surplus measures. The model is used to derive the medium- to long-term (till 2010) policy impact in a comparative static fashion based on the base year of 1997. The model also provides short-run solutions since it applies a sequential simulation procedure year by year in which the stock change is used to link two consecutive years.

In general there are six behavioural equations and one economic identity for each commodity under each country in the LTEM framework. Therefore, there are seven endogenous variables in the structural-form of the equation set for a commodity under each country[4]. There are four exogenously determined variables but the number of exogenous variables in the structural-form equation set for a commodity vary based on the cross-price, cross-commodity relationships. The behavioural equations are domestic supply, demand, stocks, domestic producer and consumer price functions and the trade price equation. The economic identity is the net trade equation, which is equal to excess supply or demand in the domestic economy. For some products the number of behavioural equations may change as the total demand is disaggregated into food, feed, processing industry demand, and are determined endogenously. The number of behavioural equations for some countries may also change since raw milk production is separated into three regions.

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[1] See http://members.aol.com/vorecon/vorsim.html.

[2] See Ervin (1999) for definition and details of environmental damage functions.

[3] Symmetry condition: $\varepsilon^{S}_{ij} = \varepsilon^{S}_{ji}$, Varian (1992).

[4] There are 126 equations for each country and in total there are 2142 equations

Basically, the model works by simulating the commodity based world market clearing price on the domestic quantities and prices, which may or may not be under the effect of policy changes, in each country. Excess domestic supply or demand in each country spills over onto the world market to determine world prices. The world market-clearing price is determined at the level that equilibrates the total excess demand and supply of each commodity in the world market by using a non-linear optimisation algorithm (Newton's global or search algorithm[5]).

The sectoral focus of this study is dairy, beef and sheep. For the purposes of this study the LTEM is modified and extended in two directions. First, in order to reflect the differences among raw milk physical production systems the countries Australia, EU, New Zealand and USA are separated into three regions and these regions are modelled explicitly. Second, in order to reflect the effect of different production systems on the greenhouse gas emissions, an environmental damage function is introduced which measures the methane and nitrous oxide emissions in physical terms. At this stage, the beef and sheep sectors are not divided into regions reflecting production systems, they are presented as a whole for each country. The link between the first and second extension is made by endogenizing the nitrogen fertilizer market and numbers of animals. The relationship calculating greenhouse gas emissions and the linkage between the livestock sector and greenhouse gas emissions are presented in section 3.2.

Environmental sub-module: linking agricultural production and trade with GHG

Incorporating methane and nitrous oxide into the LTEM model required the development of an equation linking all agricultural livestock sources of these greenhouse gases. Both methane and nitrous oxide have a number of sources in agriculture, which must be captured in a single equation.

Methane: With the relatively large ruminant animal population in New Zealand, methane (CH_4) production is significant and New Zealand has an unusually high methane to carbon dioxide ratio among developed countries (Lassey et al 1992, MAF 2001).

Methane from livestock is produced from two possible sources: that produced during the digestion process ("enteric fermentation") and that from the decomposition of ruminant faecal waste ("manure management") (Lassey et al 1992). The amount of methane produced depends on the amount of food eaten as well as the type and quality of the food.

The principal determinants of gas from enteric fermentation are livestock numbers, feed intake per head, and methane production per unit intake by feed type (Lassey et al., 1992). Most animal waste decomposes aerobically on pasture in New Zealand, resulting in relatively low levels of methane emissions from manure management for this country (MfE, 2000).

[5] See Fair (1984) p. 29, Kehoe (1991) p. 2058, and Wooldridge (2002) for more explanation on Newton's global algorithm.

Nitrous Oxide: Nitrous oxide (N_20), although emitted in much smaller quantities than either methane or carbon dioxide is important because of its relative impact in terms of global warming potential. There are a number of sources of this gas arising from livestock production. The first source is defined as animal waste management systems (AWMS). Six alternative regimes for treating animal manure, (anaerobic lagoon, liquid systems, daily spread, solid storage and drylot, pasture range and paddock, used fuel, other system) are identified in the IPCC guidelines.
Emissions from agricultural soils make up a further source of N_20, which are further divided into three sections - (1) direct emission of N_20 from agricultural soils (2) direct soil emissions of N_20 from animal production, and (3) indirect emissions of N_20 from nitrogen used in agriculture (IPCC Guidelines 1996).

Direct emissions from agricultural soils result from synthetic fertiliser application, the use of animal waste as fertiliser, nitrogen-fixing crops, and crop residues. Direct soil emissions of N_20 from animal production refers to the manure deposited by grazing livestock on pasture range and paddock and left there to decompose. This is the major management regime for animal waste in New Zealand. Indirect emissions result from the atmospheric decomposition of ammonia and nitrogen oxides, and leaching.

In order to endogenize the amount of nitrogen fertilizer used (*N/ha*) for the production of raw milk in different regions, a conditional input demand function for nitrogen fertilizer was estimated[6] for each region, equation 1. In this equation, the demand for nitrogen use per hectare for example in region *a* (Na_m) is specified as a function of relative prices of the feed concentrates (pc_{mk}) to the nitrogen[7] (pc_{mN}) and quantity supplied of raw milk per hectare in region a (qsa_{mi})[8]. The variable pc_{mk} is calculated as a weighted average of consumer prices of wheat, coarse grains, oil seeds and oil meals. The weights are found by calculating the percentage share of each feed product in total feed use. The variable qsa_{mi} is included as a shift factor which proxies the technological changes in the production process and/or irregular effects that effect supplied amount of raw milk (Burrell, 1989). The coefficients β_{i1} and β_{i2} show the elasticity of fertilizer demand in region *a* with respect to change in raw milk supply in region *a* and relative prices. The β_{i2} is expected to be positive and an increase in pc_{mk} is expected to result in an increase in nitrogen demand as nitrogen fertilizer and feed concentrates are expected to be gross substitutes. At present nitrogen use is only endogenous for the dairy sector, not beef or sheep.

$$Na_m = \beta_{m0}(qsa_{mi})^{\beta_{i1}}\left(\frac{pc_{mk}}{pc_{mN}}\right)^{\beta_{i2}} ; \qquad \beta_{i1} > 0 , \beta_{i2} > 0 \qquad 1$$

Animal numbers are of critical importance in determining the methane and nitrous oxide emissions for each country. The number of animals used for raw milk, beef and sheep production in each region (NAa_{mi}) are endogenized by specifying them as

[6] Ordinary least squares (OLS) technique was used to estimate the log-linear form of the equation 1.
[7] Nitrogen price data was obtained from the FAO database, using Urea as the closest available fertiliser.
[8] Since raw milk is totally used for producing other dairy products, the nitrogen demand function is specified only for raw milk and not for the other dairy products.

a function of various product prices such as raw milk, beef and veal and sheepmeat and of input prices such as feed concentrates and nitrogen fertilizer, equation 2. The specification is based on Jarvis's (1974) livestock supply response model in which farmers' decision to build their livestock is dependent on the expected value of future meat and/or milk production. If the expected value of the future returns, which is to a certain extent based on the current price, increases then the farmers intend to retain their livestock instead of slaughtering them. In the opposite case, if the expected cost of keeping livestock exceeds the future revenues then the farmers intend to slaughter them in the short-run[9]. The estimation was carried out by using OLS on the log-linear form of the equations. In equation 2, the parameters γ_{il} and γ_{ij} (own- and cross- price elasticities) reflect the response of farmers to various prices on deciding to build up (invest) their livestock. The γ_{il} is expected to be positive since an increase in raw milk price may change farmers' incentives to build dairy stock whilst the γ_{ij} is expected to be negative since an increase in producer prices of other livestock products may change farmers' incentives to build other type of livestock. A negative elasticity between dairy cow numbers and input prices ($\gamma_{ik,n}$) is also expected since rising prices of either fertilizer or feed concentrates may change the incentives towards slaughtering them instead of feeding. Two major sources were used for the livestock data: the FAO agricultural statistics database[10], and the USDA database[11]. Essentially the USDA database was used for dairy cows and where statistics were available from both sources, they appeared to be consistent.

$$NAa_{mi} = \gamma_{m0} pp_{mi}^{\gamma_{i1}} \prod_j pp_{mj}^{\gamma_{ij}} \prod_{k,n} pc_{mk,n}^{\gamma_{ik,n}} \quad ; \quad \gamma_{i1} > 0, \ \gamma_{ij} < 0, \ \gamma_{ik,n} < 0 \qquad 2$$

Calculation of coefficients for greenhouse gas production.

The calculation of coefficients for methane and nitrous oxide production from livestock systems is based on the IPCC methodology for greenhouse gas inventories[12]. Methane and nitrous oxide are separated into their sources. Default emission factors provided by the IPCC are used for the calculation of coefficients in most countries. In the case of nitrous oxide production in New Zealand, the emission factors are based on the latest research, and differ from the default IPCC values.

For the purposes of the model used in this study, a single coefficient representing the total methane and nitrous oxide produced from all livestock sources, and for each animal type was calculated. Soil scientists at Lincoln University (Clough and Sherlock 2001) combined the emission factors for the various sources into one coefficient for the production of nitrous oxide and one for the production of methane per animal. A single coefficient for the nitrous oxide emitted from nitrogen fertilizer was also calculated, constant across animals and countries. At this stage in the LTEM, New Zealand has more accurate nitrous oxide coefficients as a result of research carried out here. The other countries' methane and nitrous oxide coefficients are based on default values at present. Further research will involve using more accurate values for other countries in the model such as Australia, the EU and the US.

Greenhouse gases (GHG) are incorporated into the model through equation 3. In this equation GHG is specified as a function of applied nitrogen and number of animals, and methane and nitrous oxide emissions from these sources are converted to their carbon equivalents. Nitrogen application is endogenous to the model in the dairy sector, thus enabling methane and nitrous oxide emissions to be calculated as in equation 10, and multiplied by their respective weightings (21 and 310) to give CO_2 equivalents. At present nitrogen application is exogenous for beef and sheep.

$$GHG_j = \alpha NA + \beta(N, NA) \qquad 3$$

Finally the domestic supply functions for raw milk in regions, and beef and sheep in total are respecified and reestimated based on Jarvis' (1974) supply response model. The new specification includes the price of nitrogen fertilizer and number of animals, as well as the previously included variables, in order to analyse the supply effect of changes in nitrogen usage in raw milk production and number of animals. The original and respecified domestic supply functions are given in equations 4 and 5 respectively. The log-linear form of equation 5 is estimated by using OLS. In this equation the elasticity of supply with respect to nitrogen fertilizer price (α_{iN}) is expected to be negative and with respect to number of animals is expected to be (α_{iNAa}) positive.

$$qsa_{mi} = \alpha_{i0} shf_{qs}^{\ 1} pp_{mi}^{\alpha_{ii}} pp_{mj}^{\alpha_{ij}} \prod_k pc_{mk}^{\alpha_{ik}} \qquad 4$$

$$qsa_{mi} = \alpha_{i0} shf_{qs}^{\ 1} pp_{mi}^{\alpha_{ii}} pc_{mN}^{\alpha_{iN}} NAa_{mi}^{\alpha_{iNAa}} \prod_j pp_{mj}^{\alpha_{ij}} \prod_k pc_{mk}^{\alpha_{ik}} \quad ; \quad \alpha_{iN} < 0, \ \alpha_{iNAa} > 0 \qquad 5$$

Simulation Results in 2010

The LTEM was calibrated using 1997 as the base year. It was then used to simulate forward to 2010 under three different scenarios:

1. All countries default emission factors
2. NZ more accurate N_2O emission factors
3. All countries more accurate N_2O emission factors

The accurate nitrous oxide emission factors for NZ are based on the latest research conducted in New Zealand (Clough and Sherlock 2001). The default emission factors are obtained from the IPCC guidelines for greenhouse gas inventories (IPCC 1996), and the third scenario uses the emission factors used in scenario two across the four countries of interest (Australia, the EU, New Zealand and the USA). Obviously these values used in scenario three are not the actual values calculated for

[9] The similar approach is also used in AGLINK model of the OECD (OECD, 1991).
[10] www.FAO.org
[11] www.USDA.gov
[12] For details on these guidelines, see www.ipcc.org for Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook

the countries other than NZ, however they are used to show the impact of a change in emission factor.

Table 1 presents the changes in greenhouse gas emissions between scenarios one and two, ie between all countries using default emission factors, and with New Zealand using more accurate ones in scenario two. Other countries are not presented here as their emissions do not change under scenario 2.

Table 1: change in greenhouse gas emissions between scenarios one and two in New Zealand:

NZ	change in 000 tonnes CO2	% change
ghBV	0.000	0.00
ghSH	-2.739	-0.01
ghMKA	0.401	0.01
ghMKB	0.196	0.01
ghMKC	0.611	0.01
total change	1.531	

It is clear that the total change, of 1.5 thousand tonnes of CO_2, or an average percent change of less than .01 percent, is not particularly significant. However, the different emission factor does have a greater impact for some animals rather than others, such as for sheep, whose emissions decrease by 2.7 tonnes of CO_2. Essentially, the more accurate emission factors result in calculated emissions from beef remaining the same, sheep and dairy emissions decreasing. If any policy change, such as a trade or an environmental policy change occurred, resulting in increasing numbers of animals for example, the difference in emission factor may have a more important effect. Obviously it is desirable to have more accurate emission factors to enable a more realistic estimation of total greenhouse gas production to be developed.

Table 2 shows the effect of changing emission factors in Australia, the EU and the US, to the more accurate ones that have been developed for New Zealand.

	change in 000 tonnes CO2	% change		change in 000 tonnes CO2	% change		change in 000 tonnes CO2	% change
AU			EU			US		
ghBV	-0.001	-0.095	ghBV	0.000	-0.046	ghBV	-0.004	-0.404
ghSH	-7.257	-0.004	ghSH	-5.240	-0.016	ghSH	-0.484	0.000
ghMKA	0.359	0.005	ghMKA	0.596	0.001	ghMKA	0.151	0.002
ghMKB	0.074	0.004	ghMKB	0.938	0.004	ghMKB	0.407	0.015
ghMKC	0.144	0.005	ghMKC	0.601	0.002	ghMKC	0.467	0.004
total change	-6.681		total change	-3.105		total change	0.537	

Again, these changes are not remarkable. Sheep emissions decrease by varying amounts, the largest of which is 5.24 thousand tonnes of CO_2 equivalents in the EU. Projected emissions from beef change very little, generally slightly more in the dairy sector, but still not greatly. The total change in emissions is the greatest in Australia, where they decrease by nearly seven thousand tonnes of CO_2 equivalents. The US sees an increase of only 500 tonnes.

Discussion

These results are particularly important for New Zealand agriculture. As discussed previously, agriculture accounts for 55 percent of the country's greenhouse gas emissions, and has already been identified as a potential area for emission reductions to occur. The present New Zealand government appears to be serious about ratifying the Kyoto Protocol, and even at current emission levels this would mean some form of policy designed to reduce greenhouse gases. Under New Zealand's commitment to the Kyoto Protocol, emissions must be reduced to 1990 levels. Any factor that would alter the predicted levels of emissions should be taken seriously. Research to date has indicated that the default values provided by the IPCC for N_2O from sheep in New Zealand are considerably higher than values gained from research here, while the actual emission rate for dairy in New Zealand is higher than the value suggested by the IPCC. While these changes do not appear significant from the results shown in this paper, if producers were to pay a carbon tax on emissions for example, it would be vital to have the most accurate estimate of emissions.

Further Research

The LTEM is to be further modified to include beef and sheep production systems. Supply elasticities will be estimated for these and existing elasticities re-estimated to create a more accurate model.

As an extension to this paper, emission factors for both methane and nitrous oxide based on the latest international research will be added to the model in the major countries, to enable a more accurate picture of global greenhouse gas emissions to be calculated. Sensitivity analyses may be carried out to determine the importance of these more accurate emission factors.

In addition to simulations, the LTEM will also be calibrated to enable a number of policy scenarios to be run. These will include a limit on the number of animals. From the equations presented earlier in this paper, it is clear that a reduction in animal numbers will have an effect not only on production, but also on the greenhouse gas emissions. This may be imposed by either a limit on the total number of animals per region, or by a limit on the stocking rate. An alternative scenario is a limit on the nitrogen applied. This will also have an effect on production and greenhouse gases. Similarly, a tax on nitrogen will be simulated. A limit on the actual greenhouse gases will also be modelled, which will affect animal numbers, nitrogen applied and quantity supplied.

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PUBLIC PERCEPTIONS OF NEW ZEALAND'S STATE OF THE ENVIRONMENT – HOW 'CLEAN' AND HOW 'GREEN'?

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Abstract

New Zealander's perceptions of the state of the New Zealand environment were examined in a second Lincoln University national survey, conducted in March 2002. We report the public's perceptions of environmental quality in New Zealand, and comment on the claim that New Zealand has a 'clean green' image. The paper reports the public's perceptions of the causes of environmental damage, and comments on the items which might be tackled to support a 'clean green' image for international trade.

JEL: Q0, Q1.

1. INTRODUCTION

New Zealand has developed a number of strategies, and committed significant resources toward environmental goals, most recently beginning in 1995 following release of the Environment 2010 Strategy (MfE 1995). The goals of that strategy included: development of a sustainable land management strategy, ensuring that water was safe for swimming and for drinking, maintenance or improvement of air quality, maintain areas of indigenous forest, prepare a national biodiversity strategy, develop national and regional pest management strategies (OECD, 1996). The present government is preparing a sustainable development strategy.

New Zealand is often described as 'clean and green', and international marketing highlights the environment as a key feature of New Zealand. Reality may not match the slogans or advertising straplines, and considerable effort is being invested in developing state of the environment reporting, and resource accounting to ensure that New Zealand can better document its environmental performance (Department of statistics 2002). Earlier efforts to document the state of the New Zealand environment include Department of Statistics (1993), MfE (1997) and OECD (1996). Those documents focus on primarily biophysical indicators. There are however, few New Zealand publications documenting New Zealanders' perceptions of the environment.

The first State of the Environment Reporting (SER) exercise based on a survey of New Zealanders' perceptions of the environment in 2000 was reported by Hughey et al. (2001) using a survey based on the Pressure-State-Response model. OECD (1996) and MfE (1997) explain this model, which is used internationally as the basis for environmental reporting. The Hughey et al. (2001) survey was designed to be undertaken biennially and this paper, providing an overview of some key resource areas in relation to the 'clean green' perception of New Zealand, is drawn primarily from the findings of the 2002 survey, with some reference to the 2000 survey as appropriate. The survey asks respondents directly if they believe New Zealand is 'clean and green'. We report responses to that and several other questions. We focus on water, air and 'biodiversity' to provide a representation of public perception of the state of the environment. An additional focus is on an analysis of responses according to the ethnic background of respondents, i.e., Maori, NZ European or 'other'.

The main aims of the ongoing research programme are to measure, analyse and monitor changes in New Zealanders' perceptions, attitudes and preferences towards a range of environmental issues, ultimately contributing to improved state of the environment reporting. A component of each survey is a set of questions focusing on a topical issue, natural hazards in 2000, and the marine environment and recreational fishing in 2002.

2. SURVEY METHOD

A postal questionnaire based on the Pressure-State-Response (PSR) model was developed to gather information on New Zealanders' perceptions of the environment and environmental management. The postal questionnaire was used to gather this information.

2.1 THE QUESTIONNAIRE

Questionnaire items were presented in an A5-size booklet with questions on facing pages. Each questionnaire had fourteen pages of questions. A letter of introduction stating the purpose of the questionnaire, introducing the topics in the questionnaire and inviting voluntary participation was included. The questionnaire contained a total of 135 questions, seven of which were specifically linked to freshwater issues, six to air, and fourteen to biodiversity issues. 'Biodiversity' was subdivided into 'native land and freshwater plants and animals' and 'native bush and forests.' In this paper we focus on the former of those two categories. Other questions, including those reporting demographics, are also relevant and are referred to as appropriate.

The water, air and biodiversity -related questions in the 2002 survey were the same as those asked in 2000. The PSR framework guided the development of survey questions. Three sets of questions assessed perceptions of the state of water, air, biodiversity (and six other environment components) and three sets of questions assessed perceptions of the response by management. For all of these measures a 'don't know' option was provided for respondents who did not feel they were sufficiently informed to respond. Perceived pressures were assessed by one set of questions. Further questions supplemented the PSR framework. These included measurement of the main perceived causes of damage to the environment. Nine questions sought demographic information, with the region of residence being determined by respondent's address.

The first question concerned knowledge about environmental issues and with whether New Zealand is 'clean and green'.

The State of Air/Fresh Water/Biodiversity

Three questions measured the state of water/air/biodiversity. The first question was: *Please indicate what you think the state of each of the following is.* Followed by (*inter alia*): *The quality or condition of New Zealand's air, fresh water, etc.* A five-point scale was provided for measurement, anchored by *very good* and *very bad.*

The second question regarding the state of water/air, etc., asked: *We would like your opinion on the availability or amount of some of our natural resources.* Water was one of nine natural resources evaluated. The set was presented with five-point scales anchored by *very high* and *very low.*

The third measurement was of perceptions of change in the state of 13 environmental aspects over the last five years. These were taken with the invitation: *Now that you have told us what you think about the state of New Zealand's environment, we would like you to tell us how you think the environment has changed over the last 5 years.* Questions took the form: *Compared to five years ago the quality of air/fresh waters/, etc is?* These aspects were presented with a five-point measurement scale anchored by *much better* and *much worse.*

PRESSURES ON THE ENVIRONMENT

The PSR framework includes pressures on the environment. Perceived causes of adverse environmental effects were measured by presenting a table containing ten aspects of the New Zealand environment (including air, fresh water, and 'biodiversity') with fifteen potential causes. Respondents were instructed to select up to three causes. This approach was designed to assist respondents by removing the necessity to select the single most important item from the fifteen presented.

ADEQUACY OF ENVIRONMENTAL MANAGEMENT – THE RESPONSE

A set of questions designed to measure current management of different resources was then presented. Thirteen items were presented in the form: *Currently in New Zealand air, fresh water, etc., are?* These items were each presented with a five-point response scale anchored by *very well managed* and *extremely poorly managed.*

Another set of management questions was designed to establish whether management had improved or had become worse over the previous five years. The question asked: *Compared to 5 years ago, management of New Zealand's air, etc., is?* These items were presented with five-point response scales anchored by *much better* and *much worse.*

ALLOCATION OF GOVERNMENT FUNDS

The 2002 survey differed from the 2000 survey in terms of how respondents were asked to consider expenditure preferences. The latter mixed the major overall areas of government expenditure with some specific conservation and environment expenditure items. While these results were interesting, it was decided to improve the question in 2002 by separating the general areas of government expenditure from specific areas in environment and conservation. Despite these changes an effort is made to compare findings between surveys, although these comparisons need to be made with care.

To enable comparison between preferences for the allocation of government spending on conservation and the environment within the existing budget, respondents were asked whether they considered more or less should be spent on eleven items. The question began by stating: *Now we would like to know how you would* ***reallocate the Government's expenditure on Conservation and the Environment****. Total spending on Conservation and the Environment would not change. Please tick one box for each spending category to show how you would change the allocation of government spending if* ***total spending is the same as now.*** Measurement was then taken on five- point scales anchored by *we should spend far more* and *we should spend far less.*

DEMOGRAPHIC INFORMATION

Information was sought regarding gender, age, country of birth, ethnicity, education, current situation, paid employment, the industry the person worked or had last worked in, and personal income. These were measured in some cases using categories from the 2001 New Zealand Census. Demographic information and the categories for their measurement are provided in Appendix 1, with comparisons between the 2000 and 2002 data sets. In addition, numbering of each survey allowed derivation of respondents' residential locations, which were subsequently categorised into three regions (southern, central and northern), and into two categories (either within the five major urban centres, or elsewhere).

Some preliminary work has been carried out to determine the representativeness of survey respondents compared to the New Zealand population. Both gender (χ^2=4.86; DoF=1; p=0.028) and age (χ^2=13.46; DoF=5; p=0.019) were significantly different to comparative population data. Disproportionately more females and slightly older age groups responded (Table 1).

Table 1: Demographic Data for the Survey Sample and the Comparative NZ Population.

Demographic	Group	Survey sample	New Zealand
Gender	Male	44%	48%
	Female	56%	52%
Age Band	20-29	15%	19%
	30-39	19%	22%
	40-49	20%	20%
	50-59	19%	16%
	60-69	13%	11%
	70+	14%	12%

2.2 DISTRIBUTION

Two thousand questionnaires were distributed to randomly selected individuals drawn from the New Zealand electoral roll. The questionnaire and the letter of introduction were posted with a freepost return envelope. The questionnaires were posted on 9 March 2002. In addition, a follow-up postcard on 28 March 2002 and a second questionnaire posting to non-respondents was made on 18 April 2002 to those who had not returned their questionnaire.

2.3 RESPONSE

The survey received an effective response rate of 45% (N= 836) (2000 survey response rate of 48 per cent; N = 894). Both surveys had maximum margins of error of 3% at the 95% confidence interval.

2.4 METHODS OF ANALYSIS

Due to the large number of relationships tested, in general only summarised results for significant relationships (p <0.1) are reported. Description of the components of the model is undertaken with means and standard deviations for interval or ratio data, and frequency of occurrence for categorical data measured on either nominal or ordinal scales. Where measured, 'don't know' responses are also provided.

Descriptive data for each of the resource-related questions are provided in Section 3, along with a comparison of 2002 survey results with those from 2000. Relationships between parts of the PSR framework and ethnicity were explored and are presented here as well. Chi square tests were used to test for changes in responses. Data conglomeration was necessary in some areas because there were too few valid responses in some cells to enable appropriate testing to be undertaken.

3. RESULTS

Results are presented in two main ways. First, descriptive statistics are provided in relation to each of the questions and where possible these are plotted against 2000 findings. Second, for most questions there is an analysis of responses against ethnicity. Because sample sizes are too small in some cells we have clumped responses in this analysis for most questions.

3.1 "CLEAN AND GREEN"

Table 2 summarises responses to the question concerning New Zealand's 'clean and green' environment. Clearly, most respondents either agreed or strongly agreed with the statement. In terms of ethnicity (Figure 1) there is a significant difference (χ^2=14.82; DoF=4; p=0.005) between the views of Maori (only 45.7% of whom strongly agree or agree NZ is regarded as clean and green), NZ European (with 66.9%) and others (with 77.3%). This trend is reversed in terms of the proportions that disagree or strongly disagree versus those who agree or strongly disagree. Notably very few respondents expressed a 'don't know'.

Table 2: Is New Zealand's Environment Clean and Green?

New Zealand's environment is regarded as "clean and green". Do you ...	N	Strongly agree (1)	Agree (2)	Neither agree nor disagree (3)	Disagree (4)	Strongly disagree (5)	Don't know	Mean (1-5)	Std. Dev.
		%							
	816	9.2	57.0	17.6	13.7	2.0	0.5	2.4	0.9

3.2 STATE OF THE ENVIRONMENT

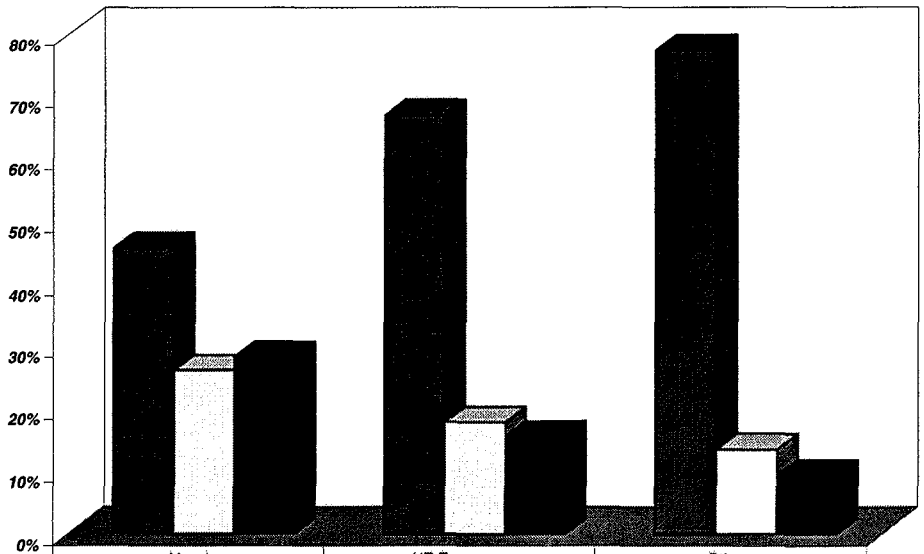
a) Quality of water/air/biodiversity in New Zealand

Table 3 shows that perceptions of the state of New Zealand's water/air/biodiversity are that it is generally *good* to *adequate* and the results from 2002 are not significantly different to those obtained in 2000. Ethnic differences are apparent, and highly significant (p<0.01) for all three resources (see Appendix 2 for detailed data). In all cases more Maori respondents consider the state of the environment worse than do Europeans or others, the latter always giving it the highest ratings.

Table 3: Perceived Quality or Condition of Natural Resources in New Zealand.

Quality of ...	N	Very good (1)	Good (2)	Adequate (3)	Bad (4)	Very bad (5)	Don't know	Mean (1-5)	Std. Dev.
		%							
Air									
2002	795	15.8	43.5	29.6	8.8	1.5	1.5	2.4	0.9
2000	866	20.0	47.0	23.6	7.2	1.3	1.3	2.2	0.9
Fresh waters									
2002	803	12.1	34.2	36.5	11.1	2.4	3.7	2.6	0.9
2000	875	11.7	35.3	35.1	12.2	1.9	3.8	2.6	0.9
Biodiversity									
2002	808	14.6	40.8	30.2	9.2	1.7	3.5	2.41	.92
2000	870	12.6	42.8	29.9	10.1	1.8	2.8	2.4	0.9

Figure 1: New Zealand's environment is "clean and green" versus ethnicity



	Maori	NZ European	Others
Agree	45.7%	66.9%	77.3%
Neither	26.1%	17.7%	13.4%
Disagree	28.3%	15.4%	9.3%

b) Change in the State of the Environment

As shown in Table 4 respondents generally considered that either no change in air or water quality or a change to the worse had occurred over the last five years. Less than 20% of either group of respondents considered improvements had occurred, with nearly 40% of respondents reporting a worsening of air quality and 30% a worsening of water quality. There is a significant difference between the 2002 and 2000 surveys (p=0.071), with 2002 respondents rating changes slightly more positively. There were no significant differences between the perceptions of the three ethnic groups (p>0.10).

Table 4: Change in State of Environment Over Last Five Years.

Change in quality over last five years for ...	N	Much better (1)	Better (2)	No change (3)	Worse (4)	Much worse (5)	Don't know	Mean (1-5)	Std. Dev.
		%							
Air									
2002	805	0.9	11.2	44.5	34.5	3.3	5.6	3.3	0.8
2000	846	3.5	10.2	47.1	32.7	2.7	3.8	3.2	0.8
Fresh waters									
2002	805	1.7	16.3	44.5	25.8	3.0	8.7	3.1	0.8
2000	843	2.3	12.5	42.7	30.1	4.4	8.1	3.2	0.8
Biodiversity									
2002	807	1.9	22.2	38.7	23.4	2.0	11.9	3.0	0.8
2000	853	2.6	17.2	42.2	25.3	2.1	10.6	3.1	0.8

3.3 MANAGEMENT OF THE ENVIRONMENT

a) Current management

Perceptions of quality of management of particular environments are reported in Table 5. Between 60-70% of respondents considered each of the three resources to be adequately or better managed. While there were no significant differences between surveys for water or biodiversity (p>0.10), more people in 2002 considered management of air was worse than did so in 2000 (χ^2=14.149; DoF=5; p=0.015).

Table 5: Perceptions of Current Management of Resources.

Perceived quality of management of ...	N	Very well managed (1)	Well managed (2)	Adequately managed (3)	Poorly managed (4)	Very poorly managed (5)	Don't know	Mean (1-5)	Std. Dev
		%							
Air									
2002	805	1.6	15.2	45.7	26.6	4.6	6.3	3.2	0.8
2000	851	2.8	20.1	45.7	22.9	2.9	5.5	3.0	0.8
Fresh Water									
2002	807	2.4	20.4	45.5	18.1	3.2	10.4	3.0	0.8
2000	846	3.3	20.1	45.3	17.6	3.2	10.5	3.0	0.8
Biodiversity									
2002	805	2.2	24.6	47.3	14.8	1.4	9.7	2.9	0.8
2000	849	3.3	22.5	46.8	17.1	1.6	8.7	2.9	0.8

b) **Management of Air/Water/Biodiversity Compared to Five Years Ago**

Perceived changes in quality of management of over the previous five years are reported in Table 6. Most people thought that management was the same as or better than five years ago with no significant differences for water or biodiversity between the 2002 and 2000 surveys (p>0.10). However, for air, there has been an increase in the amount of adverse perception of management between the two surveys (χ^2=11.661; DoF=5; p=0.040).

Table 6: Quality of Management of Resources Compared to Five Years Ago.

Perceived change in management compared to 5 years ago for ...	N	Much better (1)	Better (2)	The same (3)	Worse (4)	Much worse (5)	Don't know (N)	Mean (1-5)	Std. Dev
		%							
Air									
2002	806	1.1	16.7	47.6	23.0	2.4	9.2	3.1	0.8
2000	843	3.0	16.5	51.1	18.7	2.3	8.4	3.0	0.8
Fresh Water									
2002	805	2.1	19.4	48.3	15.9	1.9	12.4	3.0	0.8
2000	837	2.9	17.6	49.5	13.9	3.5	12.8	3.0	0.8
Biodiversity									
2002	798	2.8	26.7	45.4	11.0	1.1	13.0	2.8	0.8
2000	843	3.6	29.7	42.9	12.3	1.8	9.7	2.8	0.8

3.4 MAIN CAUSES OF DAMAGE TO THE ENVIRONMENT

Respondents' judgements of the main causes of damage to the environment are reported in Table 7. Respondents were instructed to select what they considered to be the main causes of damage from a list of fifteen items. Respondents could select up to three items.

An example serves to illustrate how Table 7 should be interpreted. The top left cell in column two indicates that 87.9% of respondents indicated that motor vehicles are one of the three main causes of damage to air. In terms of water there is a significant change between 2000 and 2002 (χ^2=48.107; DoF=14; p=0.000; see Figure 2). In 2002 the most frequently cited main causes of damage were sewage and stormwater, followed by farming and by industrial activities. This can be contrasted with 2000 when sewage and stormwater, followed by hazardous chemicals and industrial activities were those most cited by respondents. The biggest change between 2000 and 2002 has been the increase in respondents choosing farming as one of the main causes of damage to freshwater. Significance of differences in proportions of respondents citing each cause in the two surveys is measured using the Z statistic. Significant changes occurred in 'farming' (p(Z)=0.000 for all three resources), forestry (p(Z)<0.10 for all three resources) and hazardous chemicals (p(Z)<0.10 for all three resources). Both farming and forestry increased significantly as causes of damage for all three resources examined whereas hazardous chemicals declined. Urban development as a factor in 'biodiversity' loss declined between 2000 and 2002.

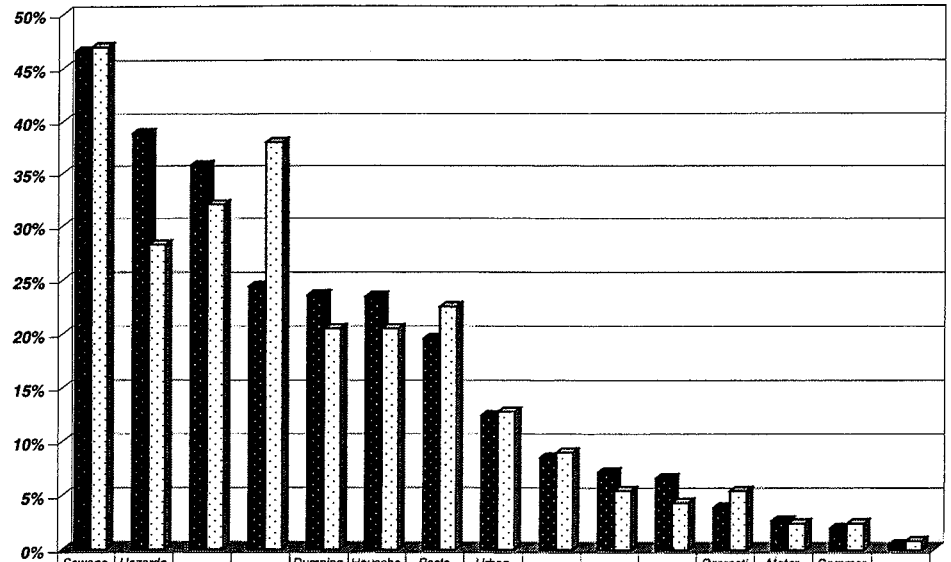
'Cause' responses have also been analysed by ethnicity. No significant differences occurred for 'biodiversity' (χ^2=24.674; DoF=18; p=0.134) but did so for air (χ^2=21.726; DoF=12; p=0.040; see Figure 3) and fresh water (χ^2=26.662; DoF=14; p=0.021; see Figure 4). For air the ethnic pattern was very mixed. Over 90% of respondents from all groups considered motor vehicles and transport were the main cause, whereas only 16.7% of Maori compared for 32.1% of NZ European respondents thought household waste and emissions were one of the three main causes. The pattern was also mixed in terms of freshwater. The highest NZ European response was recorded for farming while for Maori and 'others' it was sewage and storm water.

Table 7: Main Causes of Damage to Resources.

Resource:	Air			Fresh water			Biodiversity		
	2002	2000	Z score; 2 tailed probability	2002	2000	Z score; 2 tailed probability	2002	2000	Z score; 2 tailed probability
Main causes of damage to fresh water:	% of all survey respondents who gave this response			% of all survey respondents who gave this response			% of all survey respondents who gave this response		
Motor vehicles and transport	87.9	85.3	-1.574; p=0.116	2.4	2.7	0.312; p=0.755	4.9	4.0	-0.882; p=0.378
Household waste and emissions	28.5	28.7	0.128; p=0.898	20.5	23.5	1.390; p=0.164	8.7	10.3	1.106; p=0.269
Industrial activities	67.9	67.3	-0.269; p=0.788	32.0	35.8	1.520; p=0.128	17.9	21.0	1.623; p=0.105
Pests and weeds	3.5	4.0	0.611; p=0.541	22.5	19.6	-1.395; P=0.163	48.9	46.9	-0.855; p=0.392
Farming	5.6	2.2	-3.610; **p=0.000**	38.0	24.4	-5.688; **p=0.000**	27.9	18.9	-4.418; **p=0.000**
Forestry	1.2	0.4	-1.712; **p=0.087**	4.3	6.6	1.921; **p=0.055**	12.8	15.5	1.642; **p=0.101**
Urban development	12.4	13.3	0.541; p=0.589	12.8	12.4	-0.196; p=0.844	18.4	21.8	1.762; **p=0.078**
Mining	1.1	1.5	0.704; p=0.481	9.0	8.5	-0.309; p=0.758	10.8	9.7	-0.708; p=0.479
Sewage and storm water	5.1	5.1	0.002; p=0.999	46.9	46.6	-0.150; p=0.881	20.8	22.5	0.843; p=0.399
Tourism	0.7	0.6	0.157; p=0.875	5.4	7.2	1.367; p=0.172	7.7	6.0	-1.328; p=0.184
Commercial fishing	0.2	0.6	1.062; p=0.288	2.4	2.0	-0.544; p=0.587	1.6	2.1	0.884; p=0.377
Recreational fishing	0.0	0.1	1.001; p=0.317	5.4	3.9	-1.380; p=0.168	0.6	1.0	0.956; p=0.339
Dumping of solid waste	7.4	8.6	0.917; p=0.359	20.5	23.6	1.452; p=0.147	18.9	19.5	0.298; p=0.766
Hazardous chemicals	23.8	27.6	1.822; **p=0.068**	28.2	38.9	4.362; **p=0.000**	17.0	21.9	2.602; **p=0.009**
Other	1.3	0.6	-1.622; p=0.105	0.8	0.5	-0.643; p=0.520	0.7	1.0	0.652; p=0.515
Number of survey respondents	**836**	**894**		**836**	**894**		**836**	**894**	
Number of people answering this question	**760**	**819**		**737**	**741**		**707**	**769**	

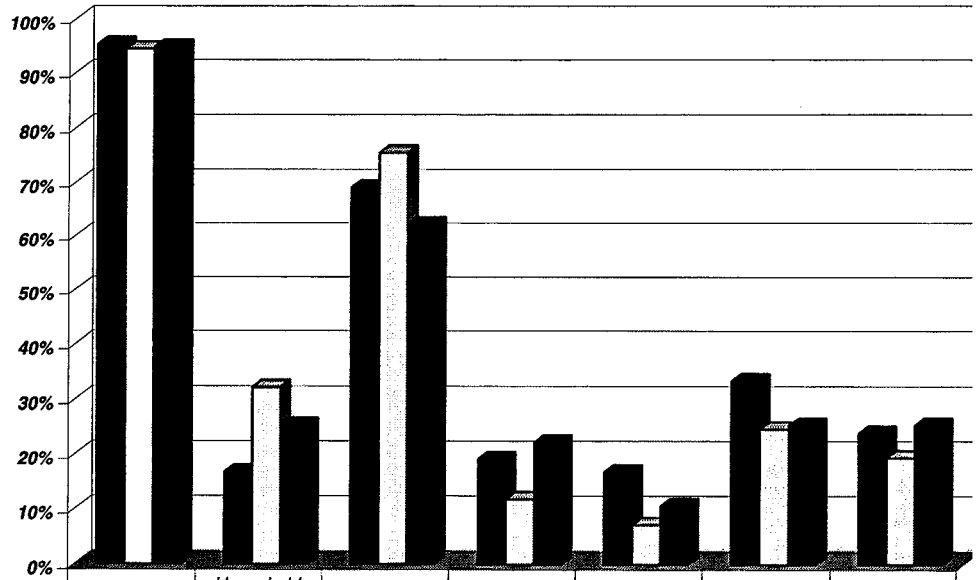
Note: Percentages add to more than 100 because respondents could nominate up to 3 causes.

Figure 2: Perceived causes of damage to fresh waters



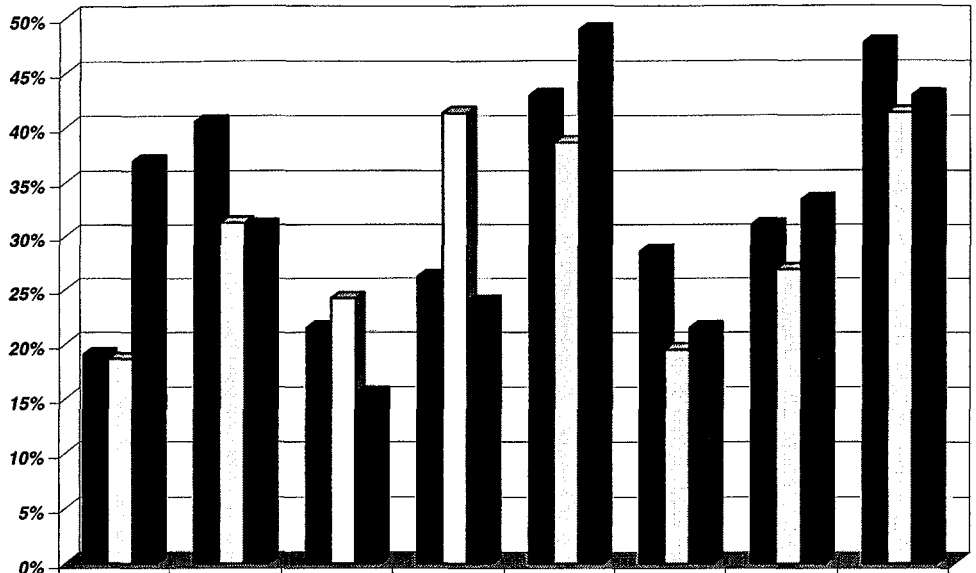
	Sewage and storm	Hazardous chemical	Industrial activities	Farming	Dumping of solid waste	Household waste and	Pests and weeds	Urban development	Mining	Tourism	Forestry	Recreational fishing	Motor vehicles and	Commercial fishing	Other
■2000	46.6%	38.9%	35.8%	24.4%	23.6%	23.5%	19.6%	12.4%	8.5%	7.2%	6.6%	3.9%	2.7%	2.0%	0.5%
□2002	46.9%	28.2%	32.0%	38.0%	20.5%	20.5%	22.5%	12.8%	9.0%	5.4%	4.3%	5.4%	2.4%	2.4%	0.8%

Figure 3: Main causes of damage to air versus ethnicity



	Motor vehicles and transport	Household waste and emissions	Industrial activities	Urban development	Dumping of solid waste	Hazardous chemicals	Other
■ Maori	95.2%	16.7%	69.0%	19.0%	16.7%	33.3%	23.8%
□ NZ European	94.4%	32.1%	75.4%	11.7%	7.1%	24.6%	19.3%
■ Other	94.7%	25.3%	62.1%	22.1%	10.5%	25.3%	25.3%

Figure 4: Main causes of damage to fresh water versus ethnicity



	Household waste and emissions	Industrial activities	Pests and weeds	Farming	Sewage and storm water	Dumping of solid waste	Hazardous chemicals	Other
■ Maori	19.0%	40.5%	21.4%	26.2%	42.9%	28.6%	31.0%	47.6%
□ NZ European	18.6%	31.2%	24.2%	41.3%	38.6%	19.5%	26.8%	41.3%
■ Other	36.9%	31.0%	15.5%	23.8%	48.8%	21.4%	33.3%	42.9%

3.5 ALLOCATION OF GOVERNMENT SPENDING

Respondents were asked to reallocate the existing budget amongst a selected set of items. Total budget spending remained fixed. We provide data on preferences for spending on water as one example (Table 8). In 2002 people wanted more expenditure on water, whereas in 2000 they either wanted no change or more expenditure on water. There is a highly significant difference between the two surveys (p=0.0022). This response is not surprising given the earlier result that people judged the quality of water has declined in the past two years.

Table 8: Preferences for Allocation of Government Spending.

Preferences for spending on fresh water...	N	Spend far more (1)	Spend more (2)	No change (3)	Spend less (4)	Spend far less (5)	Mean (1-5)	Std. Dev
		%						
2002	770	13.3	45.6	38.7	2.1	0.3	2.3	0.7
2000	860	11.6	39.3	47.9	0.8	0.3	2.4	0.7

3.6 MAJOR ENVIRONMENTAL ISSUES

Respondents were asked to identify the most important environmental issue facing New Zealand today (Table 9). Pollution of a variety of sorts is the main issue identified in the survey.

Table 9: Most Important Environmental Issues Facing New Zealand.

Environmental Issue	% of valid responses
Air quality/pollution	17.3
Waste disposal and industrial pollution	11.8
Introduced pests, weeds and diseases	10.9
Water quality/pollution	10.8
Urban environment, population pressure and tourism	6.5
Climate change and ozone layer	6.3
Sustainable management of resources	6.3
Pollution (unspecified)	6.2
Wildlife and natural environment	5.9
Protecting environment/keeping New Zealand clean, green	5.6
Environmental education	3.8
Other	8.6
Total	100.0

4. DISCUSSION

A Pressure-State-Response model (as used for state of the environment reporting) approach guided data collection and subsequent analysis. We have focused in this paper on 'clean and green', and three components of the environment, water, air, and 'biodiversity'. Some key points identified in this selective research include the following:

- Respondents think New Zealand is clean and green, and this is in keeping with the reputation of New Zealand held abroad (Thornton et al. 2001)
- While respondents were happy with the state of water, air and native biodiversity, they are not so happy about trends in the state of air and, for water at least, would like more expenditure on the problems.
- It is notable that farming is increasingly considered a major cause of problems to water (which is consistent with recent media reports, e.g., NZ Environment, 2002: 1).
- It is notable that in virtually all situations there is a major divergence of views along ethnic lines - Maori consider states to be worse and getting worse than do NZ Europeans and others for all three resources examined here.
- Respondents judge that most of the main environmental issues New Zealand are clumped around pollution matters and not around biodiversity management, or GE for example. This finding is also consistent with the 2000 Massey University environmental survey (Gendall et al. 2001).

Most respondents agreed with the statement that New Zealand is 'clean and green'. However, it is clear that neither Maori nor NZ European are as convinced about this view as is the 'other' ethnic group. One possible explanation for this result is the 'other' ethnic group may contain a high proportion of relatively recent immigrants to New Zealand who judge that New Zealand is 'clean and green' compared to the environment in their source country. Further research is needed to determine if that is a valid explanation for the difference in views.

Our examination of air, water and biodiversity has identified some issues and anomalies. A general finding from this work is that on average New Zealanders consider the state of their environment to be adequate to good. This response is consistent across the resources of: air, water and biodiversity. While the state of the environment overall is thought of very highly, there seems to be a sizeable minority view (between 30-40% of respondents), who consider that the state of the environment has deteriorated over the past few years. This common perception of resource deterioration contrasts somewhat with perceptions about management of those same resources. The vast majority of survey respondents think management has remained the same or improved over recent times.

Relative to many other countries it is probably true that the state of the New Zealand environment is adequate to good. Population density at 14 per km^2 is the fourth lowest in the OECD (OECD, 1999) and the pressures on the environment are much higher in more densely populated nations. A recent international study rated New Zealand, nineteenth for its environmental sustainability (World Economic Forum, 2002). These aggregate measures disguise areas where New Zealand environment performance is noteworthy and we comment on some of these below.

Air

There is increasing concern amongst scientists about the health effects of air pollution in New Zealand, e.g., Fisher et al. (2002) regarding increased mortality from vehicle emissions in the greater Auckland region, and Hales et al. (2000) who linked increases in air-borne particulates to increased mortality and to an increase in respiratory hospital admissions in Christchurch. Despite these growing concerns, MfE (1997: 6.10) found that New Zealand has generally clean air, e.g., MfE (1997: 6.24) reported that "as with suspended particulate matter, smoke levels around the country have also shown some improvements over the last 10 to 20 years". However, in cities such as Christchurch, for example, while "wintertime levels of smoke have decreased - significantly in the case of Christchurch - especially over the last decade" MfE (1997: 6.24), smog levels still regularly exceed World Health Organisation limits every winter.

From the survey it is clear that New Zealanders generally believe that air quality is good and management of air is deemed to be adequate. This view is consistent with the World Economic Forum (2002) finding that ranks New Zealand first of 142 nations in terms of air quality. The majority of survey respondents, nevertheless, believed air quality had declined in the last 5 years - this perception is at odds with 'clean and green' image.

Water

An OECD review of New Zealand's environmental performance judged that ... 'thanks to a very low intensity of water use and low overall levels of pollutant discharges from point sources, New Zealand's rivers, lakes and groundwater *generally present very high water quality*' (OECD, 1996: 181). In general respondents to our survey rated water quality as adequate to good but they also judged that water quality is deteriorating. Farming was judged by 38% of respondents to be a major cause of damage to water. This result may at least partly be the result of a 'dirty dairying' campaign by Fish and Game Councils (see for example New Zealand Environment 2002: 18). If the perception is that farming is a major source of damage then this may have trade implications for trade in dairy products where New Zealand trades on its 'clean and green' image.

Biodiversity

Conservation of native plants and animals is one of New Zealand's main environmental issues (DoC and MfE 2000). This policy view is supported by findings from the World Economic Forum (2002), that reported New Zealand's biodiversity performance as worst of 142 nations. There is a diverse flora and fauna in New Zealand, with about 1000 threatened or endangered plant and animal species (DoC and MfE 2000), some of which (e.g., kakapo and kiwi) are national icons. From the survey it is clear that New Zealanders believe the condition of native land and freshwater plants and animals (biodiversity) to be adequate to good, although there is a perceived decline in this position over the last five years. Given New Zealand's international ranking and the high number of endangered species it is difficult to understand why New Zealanders think the condition of native land and

freshwater plants and animals is adequate to good. As with air then, New Zealanders' perceptions are at odds with scientific evidence.

Ethnicity and responses

Crosstab analysis indicates that responses to many questions vary significantly with ethnicity of respondents. Maori judge that water quality, and management of water is lower than do New Zealand Europeans and 'other ethnicity' respondents. Maori recognition of the land as resources as taonga, and their concerns for guardianship (kaitiakitanga) might have adverse effects on New Zealand's environmental reputation. 'Other ethnicity' people includes, Pacific Island people, and Asians. There is some evidence that Asian people have differing attitudes toward environmental management than do New Zealand Europeans and Maori (MfE, 1997: 2.9).

Major environmental issues

The identification of pollution as the most commonly cited environmental issue in New Zealand is surprising given the generally high air and water quality in New Zealand. Recent publicity attached to air quality in Christchurch, and Auckland, and water quality issues associated with dairy farming, and disposal of urban wastes, illustrates that low human population density is no longer sufficient to maintain high air and water quality (see also Gendall et al. 2001).

Concluding remarks in relation to the 'clean green' image and trade

Gendall et al. (2001) undertook a detailed examination of New Zealanders' understanding of the 'clean green' image and found that 42% believe the image is a myth. We have taken a different approach in this study and have examined individual resource areas to gain an understanding of areas in which New Zealanders' consider the major changes and issues with respect to the environment exist. Some of these results are disturbing, both from an environmental management and, potentially, from a trade perspective. While most people (over 85%) think the state of the environment is adequate or better, between 25-30% believe that the state of the three resources addressed here is getting worse. Perhaps of greatest concern is the perceived contribution of farming as the most reported cause of damage to fresh waters, and that New Zealanders perceive both farming and forestry are increasingly important causes of damage to air, fresh water and biodiversity.

Kiwis' perceptions of and pride in their environment are likely to be communicated to current and potential visitors and trade partners. Consequently, for New Zealand to maintain its international reputation of a 'clean green' environment it would appear important that New Zealanders retain the same view. The critical importance of perceptions of New Zealand's 'clean green' environment to overseas purchasers of our products has already been shown (Thornton et al., 2001). Our data indicate perceptions of a worsening environment and a growing level of interest in the impact of farming on natural resources. If these trends continue then, in time there could be spillover effects on international trade. Given that both tourism and farming obtain premiums based on the 'clean green' image, then politicians and policy makers should consider undertaking policy actions to enhance environmental management in order to maintain perceptions of environmental quality. The fact that respondents want more spent on water is, perhaps, a signal that the New Zealand public thinks so too.

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Appendix 1: Demographic Information

Information was sought regarding gender, age, country of birth, ethnicity, education, current situation, paid employment, the industry the person worked or had last worked in, and personal income. These were measured in some cases using categories from the 2001 New Zealand Census. Demographic information and the categories for their measurement are provided in Appendix 1, with comparisons between the 2000 and 2002 data sets. In addition, numbering of each survey allowed derivation of respondents' residential locations, which were subsequently categorised into three regions (southern, central and northern), and into two categories (either within the five major urban centres, or elsewhere).

Some preliminary work has been carried out to determine the representativeness of survey respondents compared to the New Zealand population. Both gender (χ^2=4.86; DoF=1; p=0.028) and age (χ^2=13.46; DoF=5; p=0.019) were significantly different to comparative population data. Disproportionately more females and slightly older age groups responded (Table 1).

Table A: Summary of Comparative Demographic Data Between the Survey Sample and the Comparative NZ Population.

Demographic	Group	Survey sample	New Zealand
Gender	Male	44%	48%
	Female	56%	52%
Age Band	20-29	15%	19%
	30-39	19%	22%
	40-49	20%	20%
	50-59	19%	16%
	60-69	13%	11%
	70+	14%	12%

Age is the only demographic for which there is a significant difference between the 2000 and 2002 respondents (Table B). The average age of respondents in 2002 is 2 years older than in 2000, and relatively more respondents 40 years and older participated in 2002 compared with 2000.

Table B. Comparison of Demographic Data Between the 2000 and 2002 Perceptions Surveys.

Demographic	Chi squared	Degrees of freedom	Probability of chi squared
Regions	4.45	2	0.11
Gender	1.33	1	0.25
Age band	24.03	6	0.001
Education	6.90	6	0.33
Current situation re employment	5.84	6	0.44
Paid employment	3.33	2	0.19
Income	1.26	7	0.99

Appendix 2: Ethnic Perceptions of Resource Quality in New Zealand

Table C: Analysis of Ethnic Differences in Perceptions of Resource Quality.

	Environmental quality ratings	Maori (N)	NZ European (N)	Others (N)	Chi squared; Degrees of Freedom; probability of chi squared
Air	Very good-good	18	378	64	χ^2=27.528; DoF=4; p=0.002
	Adequate	11	197	20	
	Bad-very bad	14	57	10	
	Total	43	632	94	
Fresh waters	Very good-good	13	294	58	χ^2=25.74; DoF=4; p=0.000
	Adequate	16	238	29	
	Bad-very bad	15	87	5	
	Total	44	619	92	
Biodiversity	Very good-good	19	353	67	χ^2=27.693; DoF=4; p=0.000
	Adequate	12	205	22	
	Bad-very bad	14	68	4	
	Total	45	626	93	

Clean, Green and Healthy? Genetically Engineered Food: A Perceived Threat to New Zealand's Brand Image

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SUMMARY

New Zealand's reputation as a clean, green country is an important branding image in international trade and an important part of our cultural self-image. One possible future threat to this brand image is the commercialised production of genetically engineered (GE) plants and animals for food. This paper uses selected data from a postal survey (n=1682) to examine the New Zealand public's perception of the fit of producing GE products with NZ's brand image. Producing GE products is strongly perceived to conflict with New Zealand's clean, green brand and reputation for producing healthy food. It is concluded that the socially responsible development of policy regarding the commercial production of GE food must take into account both the economic and social implications of this perception.

Key Words: Perceptions, clean, green, brand, genetic engineering,

INTRODUCTION

New Zealand. Clean, green and beautiful. Its practically a national mantra; a deeply imbedded cultural self-image. As New Zealanders we take pride in this image of our clean, green, unspoilt land. It is also a part of our international reputation. Overseas consumers hold a favourable image of New Zealand as clean and green (PA Consulting Group, 2001).

Wealthy trading partners are prepared to pay price premiums for products produced using sound environmental practices. The brand attribute of clean and green has for many years added value to our export products. New Zealand not only benefits from its clean green image, it also promotes it. Some of our major industries including agriculture, forestry and tourism trade on this image (Woodward-Clyde Ltd, 1999).

In a recent press release, Tourism New Zealand chairman, Wally Stone, urged New Zealanders not to underestimate the economic value of our clean, green image. He claims that New Zealand needs to preserve its clean, green brand as a strategic point of difference (Anon, 2002a).

In a world increasingly concerned with environmental issues, this is a strong brand image. How deserved this image is, is another question. Many practices in some of New Zealand's key industries including fishing and forestry are considered unsustainable (Wallace, 1997). However, although some express concerns about the environment and its management, New Zealanders still consider their environment is better than other developed nations (Cook et al, 2001). A recent report commissioned by the Ministry for the Environment concluded that "New Zealand is relatively clean and green" (PA Consulting Group, 2001).

Although recognising that, in the long term, the reality of clean and green will impact on the image, this article is primarily concerned with perceptions. For both New Zealand residents' self-image, and for overseas consumers' purchase decisions, perceptions are the realities that influence psychological states and guide behaviour.

Recent food scares in our traditional European markets have eroded public confidence in many high technology agricultural practices and also in science, industry and regulatory authorities (Irwin, 2001). Consumer concern in these high value markets has lead to an increased demand for organic food (Woodward-Clyde Ltd, 1999).

Organic food is one of the fastest growing market segments in the European food market – growing at about 20-30% a year. Currently 2% of the European food market is organic and 60-70% of organic products are imported. In 2000, European organic food retail sales were valued at 8.5 billion Euro. The market for organic foods is predicted to continue to expand rapidly in the coming years (New Zealand Food Marketing Institute, 2000).

Organic food is a high value, rapidly expanding export market that New Zealand's clean, green branding image places us in an excellent position to capitalise upon. Organic farming is suited to smaller scale, labour intensive farming, such as is traditionally practiced on the family farm in New Zealand. Research conducted with farmers and growers in New Zealand (Cook et al, 2000) found that 37% intend to use organic farming methods in the future. Many farmers (49%) agreed that NZ should try to achieve GE free status. In contrast, Cook et al found that 21% of farmers and growers intend to adopt gene technology.

Some people consider that the commercialised production of GE plants and animals for food is a potential threat to New Zealand's clean, green image. Visiting English environmentalist, Luke Anderson, warns that becoming a producer of GE crops or livestock risks destroying New Zealand's clean, green reputation and that this would mean economic suicide for New Zealand's exports to Europe. He claims that British and European supermarkets and consumers have emphatically rejected genetically modified food imports (Anon, 2002b).

Recent research provides some support for his contention. In Europe, a number of major retail chains have publicly taken a stance against GE food products. Seven major food retailers have formed a consortium to only purchase ingredients that are free of genetically modified organisms (GMOs). These retailers are: Marks and Spenser (UK), Sainsburys (UK), Carrefour (France), Superquinn (Ireland), Migos (Switzerland), Effelunga (Italy), and Delhaize (Belgium). This move has been made in order that these companies can deliver own-brand products free of GE content to their consumers (Woodward-Clyde Ltd, 1999).

Other retailers in Europe have adopted a similar stance. Iceland (UK) guarantees that none of its own-brand products contain GMOs. SPAR (Austria) took a public stance against GE food in 1998. Asda (UK) has requested that suppliers do not include products with GMOs, while Waitrose (UK) and Co-op (UK) have promised to make their own labels GE free. Tesco (UK) are expanding their organic range and avoiding GE soya products (Woodward-Clyde Ltd, 1999). A similar stance of ensuring that own-brand products are GE free has been taken by two major New Zealand supermarket retailers (Small, 2001).

New Zealand and international surveys report public concern regarding the health and safety of GE food and the long term environmental impacts (European Commission, 2000; Gamble et al, 2000). European concerns include GE being considered unnatural, unwholesome, morally dubious, leading to negative consequences and preventing happiness and inner harmony. Opponents of GE consider that it conflicts with values such as responsibility for nature and the welfare of other people (Bredahl, 2000).

Irrespective of whether these beliefs about GE food are true or not, they affect consumer behaviour. Therefore, it becomes salient to ask: will GE agriculture impact on the perception of New Zealand as a clean, green country and our reputation for marketing healthy food?

METHOD

This paper reports selected data from a survey of New Zealanders' attitudes and beliefs about GE food and medicine. The survey also explored a range of other attitudes and beliefs that previous research had identified as being related to these issues. Included in the survey were questions that directly addressed the perceived fit of producing GE products with New Zealand's clean, green image, as well as questions addressing related environmental, health and safety, and risk issues.

In addition to asking questions about respondents' beliefs and attitudes towards GE in general, and GE food and medicine in particular, we were also interested in their reactions to a specific GE product. For this purpose we developed the scenario of a hypothetical GE milk product, produced by GE cows, with specific medical benefits. Respondents were informed that the milk product would provide extra resistance to the organisms that cause gastroenteritis. It was emphasized that this was a hypothetical product (no such product actually existed), nor was work being done to produce such a product, and that there are no genetically modified milk products currently available in New Zealand.

Variables reported in this paper are respondents' attitudes towards: the fit of producing GE products with New Zealand's clean, green image, the fit of producing GE products with New Zealand's reputation for marketing healthy food, respondents' beliefs regarding GE and the environment, and respondents' ethical perceptions regarding GE. Respondents' beliefs about the safety and risks associated with the hypothetical GE milk product are also reported.

Survey items consisted of statements with which respondents' were asked to agree or disagree. The scale was anchored at one end with 'Strongly agree' and at the other end with 'Strongly disagree'. At the midpoint was the anchor: 'Neutral'. To one side of the scale respondents could tick a box if they judged the question to be not applicable to themselves or if they did not know. The scale was not numerically anchored; respondents were asked to put a mark on a line composed of 20 dashes at the point that best represented their opinion. The researchers gave a numerical value between 1 (strongly agree) and 20 (strongly disagree) to the responses based on the location of the respondent's mark.

The survey was distributed by post (March – June 2001) to a random sample of 3000 New Zealanders over the age of 18 years and stratified according to income and region. Analysis of the data was completed using Excel, and SAS. Descriptive statistics of the sample were calculated (percentages, means, standard deviations). For inferential statistics the standard error of the mean was calculated and two-tailed t-tests were used to test the non-directional hypothesis that population levels of agreement to variable statements differed significantly from the neutral mid-point (10.5) of the scale. Observed, moderate differences in the data between male and female mean responses indicated the value of conducting post hoc two tailed t-tests to test the non-directional hypothesis that male and female population mean responses differed significantly.

RESULTS

Sample characteristics

A total of 1682 valid surveys were returned, giving a response rate of 56% and a margin of error of 3% at the 95% confidence interval. Nearly 53% (n =885) of respondents were female, 47% (n = 786) were male and 0.7% (n = 11) did not report gender. About 85% (n = 1427) classified themselves as NZ European, while 4.5% identified as Maori. The remaining 9% were either composed of other ethnic minorities or did not report their ethnicity. The population mean value of all statement variables reported below differed significantly from the midpoint (10.5) of the scale by at least ($P< 0.01$).

Clean green image and marketing healthy food

Respondents strongly disagreed that the production of GE products fits with NZ's clean, green image (mean = 17.0, SD = 4). Similar results were found for the statement that GE fits with New Zealand's image of marketing healthy food (mean = 16.5, SD = 4.5). Female disagreement was significantly stronger than male for both statements ($P<0.001$).

Table 1 presents the percentage of sample respondents who agreed or disagreed that GE products fit with New Zealand's clean, green image and fit with New Zealand's image of marketing healthy food. Eleven times as many people disagreed than agreed that GE fits with NZ's green image and more than seven times as many disagreed than agreed that it fits with NZ's image of marketing healthy food.

Table 1: Percent Respondent Agreement/disagreement[1] that GE fits NZ's Image.

Statement	% Agree	% Disagree	% Don't know
Producing GE products fits with NZ's clean green image	8	88	5
Producing GE products fits with NZ's image of marketing healthy food	11	83	6

Beliefs about GE and the environment

Respondents disagreed that GE products are environmentally friendly (mean = 14.7, SD = 4.9) and strongly disagreed that the spread of GE organisms can be controlled (mean = 15.5, SD = 5.0). They also strongly disagreed that people interested in looking after the environment would want them to purchase the hypothetical GE milk product (mean = 16.0, SD = 5.0).

Females disagreed with these statements significantly stronger than males ($P<0.001$, $P<0.001$, $P<0.01$ respectively for the three statements). Table 2 presents the percentage of sample respondents who agreed or disagreed with environmental beliefs statements about GE.

Table 2: Percent Respondent Agreement/disagreement with Environmental Beliefs about GE.

Statement	% Agree	% Disagree	% Don't know
GE products are environmentally friendly	14	58	28
The spread of GE organisms can be controlled	11	55	34
People interested in looking after the environment would want me to purchase the GE milk product	12	68	20

Ethical attitudes towards GE

Respondents disagreed that using GE technology fitted with their cultural and spiritual beliefs (mean = 15.0, SD = 4.0) and disagreed that it fitted with their basic principles (mean = 14.9, SD = 5.3). Females disagreed more than males with both statements ($P< 0.001$).

Table 3 presents the percentage of sample respondents who agreed or disagreed with ethical attitude statements about the safety and risk associated with GE products

[1] In all tables in this paper: agreement = scores below 10.5, disagreement = scores above 10.5

Table 3: Percent respondent agreement/disagreement with ethical statements about GE.

Statement	% Agree	% Disagree	% Don't know
Using GE technology fits with my cultural and spiritual beliefs	18	77	5
Using GE technology fits with my basic principles	21	75	5

Beliefs about the safety and risk

Respondents disagreed that using the GE milk product would be very beneficial to them (mean = 13.6, SD = 5.7), or that the people that they went to for health advice would want them to purchase the product (mean = 14.6, SD = 4.8).

They disagreed that they would feel safe when purchasing the GE milk product for themselves (mean = 13.9, SD = 6.0) or that it would be a safe product to develop (mean = 14.2, SD = 5.1). Consistent with these beliefs they agreed that producing the GE milk product was too risky to be acceptable to them (mean = 8.0, SD = 6.4). Respondents also expressed agreement with the statement that they could not avoid the risks associated with the product even if they did not buy it (mean = 8.6, SD = 6.0). Females disagreed more than males with all of these statements ($P< 0.001$).

Table 4 presents the percentage of sample respondents who agreed or disagreed with beliefs statements about the safety and risk associated with GE products.

Table 4: Percent Respondent Agreement/disagreement with Belief Statements about the Safety and Risks Associated with the Hypothetical GE Milk Product.

Statement	% Agree	% Disagree	% Don't know
Using this product would be very beneficial to me	26	61	13
The people I go to for health advice would want me to purchase this product	14	58	28
I would feel safe when purchasing this product for myself	28	65	7
This will be a safe product to develop	17	57	26
Producing this product is too risky to be acceptable to me	55	37	9
I can't avoid the risks associated with the product even if I do not buy it	51	31	18

DISCUSSION

This study examined the New Zealand public's attitudes and beliefs related to New Zealand's brand image of clean and green. The above results show that the majority of New Zealanders perceived environmental and human health risks

associated with GE and with the hypothetical GE milk product in the survey scenario. Environmental concerns included doubting that the spread of GE organisms in the environment could be controlled and, more generally, the belief that GE would not be environmentally friendly.

Most people considered that they would not benefit from the GE milk product. They also considered that the GE milk product was unacceptably risky to produce and that they personally could not avoid the risks associated with GE products - even if they did not purchase them.

Genetic engineering technology did not fit with most New Zealanders' spiritual and cultural beliefs nor with their basic principles. Consistent with their ethical attitudes and their beliefs about environmental risks and health and safety risks, New Zealanders strongly believed that producing GE products did not fit with New Zealand's brand image of clean and green, nor did it fit with New Zealand's reputation for marketing healthy food.

These results suggest that the commercialised production of GE food products strongly conflicts with New Zealanders' self-image of our clean, green country. Our data were restricted to the subjective perceptions of New Zealanders, so we cannot say for sure how consumers in countries that we trade with would view our clean, green image if New Zealand were to commercialise production of GE food. However, given the public attitudes of our European trading partners to GE food (discussed in the introduction), it is likely that their reactions would be similar to New Zealanders.

The question arises: what affect would compromising New Zealand's clean green image have on our trade and economy? The recent Ministry for the Environment report "Valuing New Zealand's Clean Green Image" suggests that this brand may be worth hundreds of millions, possibly billions of dollars to our economy. The report indicates that significant revenue may be lost through reduction in product quantities purchased by consumers. It suggests that along with other industries, tourism, dairying and organic farming might suffer significant negative economic impacts (PA Consulting Group, 2001).

Our purpose has been to examine whether the production of GE foods would be likely to affect perceptions of New Zealand's clean, green image. It is not within the scope of this paper to attempt quantification of the economic value of damage to this brand. However, the data presented regarding New Zealanders' perceptions strongly indicate that the socially responsible evaluation of the benefits and harms of commercialized production of GE foods must take into account the likely economic impact of the loss of New Zealand's clean, green brand. The social and emotional impact of the erosion of a key aspect of our national self-identity must also be given consideration.

A third issue of social responsibility that arises is the justice or fairness of the distribution of harms and benefits to the different sectors of the community. While the agribusiness sector may experience economic benefits from GE as well as some harm from loss of the clean, green brand, other sectors may experience economic loss with little or no benefit being gained. This issue also needs to be considered when evaluating policy regarding the production of GE food.

One sector that is likely to experience harm and receive little or no benefit is the organic producers sector. The Ministry for the Environment report includes a survey of two major organic retailers in the UK. Organic Farmfoods would replace all New Zealand organic supplies within a year if New Zealand allowed the uncontrolled release of GM crops, while Worldwide Fruit would reduce supplies by 50% (PA Consulting Group, 2001). Tourism, a major contributor to the New Zealand economy, while also suffering from damage to the clean, green image, is unlikely to benefit from the production of GE foods.

Public values are susceptible to change over time. In the long term, as people become more familiar with the concept of GE food, public attitudes may become more positive – particularly if products with real benefits for consumers are developed. However, this is by no means guaranteed. Attitudes could equally become more resistant to GE. Which way public attitudes swing will likely be influenced by the attributes (benefits vs risks) of new GE products and by public trust in scientists, regulators and the biotechnology industry. The degree to which these groups are perceived to take cognizance of public concerns, and their efforts to progress gene technology in ways that the public views as socially responsible, will play a major role in the development of trust and the acceptance of the technology. New Zealanders have a right to participate in the construction of a social and environmental future that matches their values. It will be important to continue to monitor the changes in public attitudes and values regarding GE food in order to determine the direction and intensity of change over time.

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KAVA AND FORESTS: THE CHALLENGE OF SUSTAINABLE UPLAND FOREST MANAGEMENT IN POHNPEI, FEDERATED STATES OF MICRONESIA

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INTRODUCTION

Overview of Pohnpei

The name Pohnpei originates from the legend of how the island was created. Pohnpei, literally means, "upon a stone altar" (Ashby, 1993). It is located about 4,983 kilometers (2690 miles) south-west of Hawaii, or 766 kilometers (414 miles) from the equator at approximately 7 degrees north latitude and 158 degrees east longitude in the Eastern Caroline Islands (Merlin et al. 1992).

Pohnpei is the third largest island in the Federated States of Micronesia, with a land mass of 129 square miles (335 square kilometres) including coral and volcanic reef islets, averaging 13 miles in diameter. Pohnpei is roughly circular with numerous coves and peninsulas protruding along the coastline. The island is surrounded by mangrove forest and a large lagoon with a total surface area of approximately 70 square miles (179 square kilometres). The lagoon is enclosed by an outer barrier reef, which is located generally about 2 miles (3.2 kilometers) from shore. The interior is mountainous and Nahna Laud (Big Mountain) and Ngihn Eni (Ghost Tooth) are the highest elevations being over 2500 feet (760 meters) above sea level (Merlin et al. 1992).

Pohnpei's vegetation and wildlife are some of the most diverse in Micronesia. The upland forests serve as habitat for at least 269 different species of plants, of which 110 are endemic to Pohnpei. The upland forest also provides a home for the island's wildlife, and the people of Pohnpei depend on many birds and animals for subsistence or income. There are over 24 different species of birds, which nest in the upland forest, of which five species and eight subspecies are found only in Pohnpei (Raynor, 1996)

According to the 1994 census, the population of Pohnpei state is 33,000, which includes the outer islands of Pohnpei state. Of this total, about 90% are ethnic Pohnpeians, while the rest are predominantly from the other FSM states, Palau, the Marshall Islands, the United States of America, Australia and Japan.

The rapid human population growth along with high dependence on agriculture both place pressure on upland forest environment. This has resulted in much of native upland forest being converted into traditional agricultural planting areas. This environmental issue is not unique to Pohnpei. Many other Pacific islands experience the same problem, where farmers depend on the native forests for survival. Many of these areas are converted to cultivate taro, breadfruit and coconut plantations. On

Pohnpei, kava plantation is the dominant activity causing deforestation, where the farmers' main intention is to earn fast cash to support family needs.

Kava (Piper methysticum) is a drink with narcotic effect, which is derived from well-pounded roots. Kava has been a significant plant in the culture of the people of Pohnpei. The plant is sacred and is the central feature of the social and cultural functions of the people. Kava is used in several ways. It is used during ceremonial feasts (*kamadipw en wahu*) for the paramount chiefs to celebrate the start of yam season. It is used during all *nohpwei* (ceremony of first offerings to the gods and chiefs) of breadfruit and yam, the major season and staple crops. Due to kava's respectful value, it is presented anytime on visits the chiefs. It is also used to settle disputes, when someone asks for forgiveness, for marriage ceremonies or other occasions when a commoner needs to meet with the higher traditional ranked people or the chiefs (Ashby, 1990; Anson & Raynor, 1993). Kava continues to have its central feature in Pohnpei's cultural and social functions despite being commercialised.

RESEARCH METHOD

The main goal of this research is to quantify an estimated value of the forest products in Pohnpei. For this reason, a survey is appropriate in collecting such values. The survey design is based on three main objectives. First, to obtain values of the forest products, which the rural community members depend upon. Second, to gain information on the history and community members use of the upland forests. Lastly, to gain general information on the household members such as: name, age, other income sources, major concerns on the future of the forests, and so forth.

The questionnaire survey consists of open-ended, partially open-ended and close-ended questions. Open-ended questions allow free or unstructured responses. Partially open-ended questions offer a set of fixed selections with a final open choice or option of "other". Close-ended questions lead to a set of fixed choices.

Open-ended questions have several advantages: (a) allow unlimited possible responses; (b) may avoid exclusion/omission of essential information as there is no limit to responses; (c) sufficient responses or answers can be obtained showing creativity, self-expression and logic of thinking of respondents.

Partially open-ended questions create the possibility for respondents to provide a response left out by the researcher. This does not occur in the case for close-ended questions.

Therefore, in order to gather a whole range of responses, the use of all three types of questions (close-ended, open-ended and partially open-ended questions) is appropriate for this study project.

Selection of Case Study Area

Eirke village and Awak pah were selected for the following reasons. First, the size and location of these two are physically feasible for conducting a face-to-face interviews. There is no mailing system in the villages. There is only one main postal service which is located in Kolonia town; b) lack of public transportation limiting

access to further villages; c) gaining access to villagers cultivated agroforest areas requires time and effort in hours of walking.

Awak pah and Eirke villages have similar use of forest. There is not much difference between them. They could represent the local community.

A CASE STUDY OF EIRKE AND AWAK PAH VILLAGES

Eirke Village

Eirke village is situated within Nett municipality. A paved road runs 10 km south of Kolonia past the Nett District Government to Eirke village. The road continues passing Kahmar River. After passing the river, the road continues to a sharp curve indicating the starting point of Eirke village.

The main river that runs through the village is the Nanpil River, which the village depends on for protein sources such as fish and shrimps.

Awak Pah Village

Awak Pah village is the first village in the municipality of U. Awak Pah village is about 20 minutes drive when one is travelling south of Kolonia. There are no major streams or rivers, which the villagers depend on. They rely on the ocean for fish source and other sources of protein.

Socio-economic Characteristics

Eirke and Awak Pah are good examples of communities that depend heavily on the forests for their subsistence survival. The community members' future with regard to land use and resource use is uncertain. Firstly, kava has become commercialised, and demand has increased tremendously. As a result, this increases the exploitation of the upland forest resources without any long-term vision.

Secondly, most of these farmers are young without any formal education. They lack understanding of sustainable forest management. As a result, they apply unsustainable farming practices and skills, which have generated greater pressure on existing resources (Raynor, 1996)

Thirdly, community members do not have any full-time employment from the public and private sectors, due to lack of education and are used to the island's way of life. The villagers' classification of occupation is reflected in the following table. They range from being farmers to taxi drivers and so forth. The majority (21 per cent) of the villagers are farmers; twelve percent as housewife; seven percent classified their employment as other where they work as taxi drivers, line men, and so forth; and almost half of the household members are students (39 per cent) and children (10 per cent). The village members often do not last long in the private or public sectors as they do not like timely schedules. Unlike working as farmers, they work on flexible schedules, and are use to the traditional life style of being relaxed and laid back.

Table 1: Employment classification

Occupation	Total	Percentage
Farmer	39	21%
Housewife	22	12%
Student	71	38%
Government	4	2%
Health & Education	2	1%
Construction	5	3%
Wholesale & Retail	3	2%
Fishing & Agriculture	7	4%
Hotel, restaurant & bar	2	1%
Manufacturing	1	1%
Retired	4	2%
Other	6	3%
Children	18	10%

Each household has approximately two to three hectares of land. Out of the 27 households interviewed, 15 families raise pigs, nine households own chickens, dogs are raised by almost all of the households. Pigs are the most important and popular animal in Pohnpei followed by dogs and chickens. Pigs and dogs are significant as they are used during traditional occasions. The three most important items that a commoner brings to a traditional occasion are: kava, yams and pigs or dogs.

The education system in Pohnpei is modelled after the United States educational system. Public education begins with elementary school, which is free and compulsory. Most children enroll in school at the age of six and continue in school for the next eight years. Public secondary schooling is available, and the College of Micronesia-FSM provides two- and three-year programs leading to an associate degree. Private elementary and secondary schools also exist, sponsored by religious groups. However, only the well-off families are able to afford these private-owned services.

The educational achievement has increased between 1980 and 1994. In 1994, it was reported that approximately 94 percent of the population aged 10 and over are literate. The proportion of the population completing some level of education increased. The proportion with no schooling decreased from twenty-five percent in 1980 to 15 percent in 1994. The education achievement is not high with nearly fifty percent of the population only attaining elementary education. Eighteen percent achieved high

school or higher level of education. Twelve percent of adults age 15 years and over, and 19 percent of adults age 45 and 54 achieved vocational training. Overall, literacy status decreased with age showing that the older generation did not have the educational advantages of the younger generation.

The status of the health of community members is critical. Under-nourishment and being unhealthy are common among school children. This health issue causes frequent absenteeism and difficulties learning at school. Generally, the village population's diet has deteriorated mainly from the introduction of processed and packaged food. There has been an increase in malnutrition, hypertension, diabetes and other nutrition related diseases due to increased consumption of foods high in fats, salts and other undesirable chemicals, however low in nutritional value. In addition, the Health Services Plan for the FSM stated infant mortality rate is decreasing, as well as respiratory system disorders (ADB, HRD Study 1995). However, there has been an increase in diseases relating to the circulatory system, cancer, and prenatal related diseases. Majority of these diseases are related to improper nutrition. Overall, there is tremendous need in both education and health care systems in Pohnpei.

Community Members and the Forests

According to the results from the question on familiarity with the forests in Pohnpei, 100 per cent are familiar with the forests. The households visit the forests thirty times at most per month, 6.96 on an average visit per month, and others by one time per month. On these visits, they could spend up to 720 hours in the forests. On an average, the households spend 139.42 hours, and at least one hour in the upland forest.

In both villages, Eirke and Awak Pah, 100 per cent of the community members are familiar with the forests. However, in Awak Pah village only 3 per cent of the household cultivate kava in the upland forests. The remaining work in the lowland areas, where they cultivate agroforest products. As for Eirke, 100 per cent go upland and cultivate the area. The research result shows that on average, each household visits the forests 10 times or 7 times for major activities such as searching for land or planting kava respectively in the upland areas. With daily activities, results show that planting kava occupies most of the villagers' time (460 hours per month), which is followed by planting yam (146 hours per month) and searching for land (82 hours per month).

There are three major uses of the upland forest identified by the villages. Research result shows that majority (74 per cent) of the 27 households consider that planting kava as the most important use of the forests (first category). As to second most important, planting yam was given by 33 percent of the interviewed households (second category). Breadfruit was suggested by 22 percent as the third most important activity. Placing these three items as top the most important uses of the forest relating to their significant traditional uses. As for yam and breadfruit, they signify the two main seasons in Pohnpei indicating the beginning and ending of each season. See Chapter 1 section 1.3.6 for detailed discussion on the importance of kava, and Chapter 2 section 2.1.10 for discussion on the significance of yam and breadfruit. The three major important uses of the forests are reflected in the following tables.

Table 2(i): The First Most Important Use of the Forests (first category)

Item	Kava	Yam	Banana	Breadfruit	Coconut
Households	20	3	1	2	1
Percentage	74%	11%	4%	7%	4%

(Out of the total 27 interviewed households)

Table 2(ii): The Second Most Important Use of the Forests (second category)

Item	Kava	Yam	Banana	Breadfruit	D.L. Taro	Wetland	S. Taro	Coconut
Households	4	9	3	4	3	1	2	1
Percentage	15%	33%	11%	15%	11%	4%	7%	4%

(Out of the total 27 interviewed households)

Table 2(iii): Third Most Important Use of the Forests (third category)

Item	Yam	Banana	Breadfruit	D.L. Taro	S. Taro	Coconut	Pig	Tapioca	Pineap
Households	3	4	6	2	4	3	3	1	
Percentages	11%	15%	22%	7%	15%	11%	11%	4%	

(Out of the total 27 interviewed households)

Community Members' Dependence Level on the Forest

Of the households interviewed, seventy-five percent responded that the current level of dependence on the forests is much more compared to that of 10 years ago. Compared to that of 20 years ago, the current level of dependence has the same result (much more). Seventy percent of the villagers supported this, while seven percent have an unknown dependence value and five percent think their dependence level is equivalent to that of 20 year ago. The majority of the villagers (67 percent) responded saying that their current level of dependence is much more than 30 years ago. These results show that dependence level on the forests for the majority of the villagers at the present is much more compared to the last 30 years. This is consistent with the key motivation to go upland to plant kava.

Table 3: Villagers' Dependence Level on the Forest by Year

Dependence Level	Time: 10 yrs	20 yrs	30 yrs	Future
much less	0%	11%	3%	4%
little less	11%	7%	0%	15%
The same	4%	5%	4%	3%
much more	75%	70%	67%	19%
Not known	10%	7%	26%	59%

Future Options

As for the villagers' future, it is unclear or unknown. Based on the results, 59 per cent of the villagers from both Awak Pah and Eirke agreed that their dependence level on the forests is unknown. These reasons were given on why their future dependence level on the forests is not known. 1) They are aware that the forests are diminishing in size. This awareness was introduced to them during the 1995 Watershed Management Project Workshop. 2) The launch of the Low Grow Campaign in 2000. This project came about encouraging them to plant kava in the lowland areas rather

than in the upland forests. 3) The launching of lining of the Watershed Reserve boundaries. This would clearly show the boundaries of the Watershed Reserve indicating the off limits areas. Overall, these above-mentioned reasons would limit the villagers' access in the upland forests. Breaking any rules or regulations is not a smart option for the villagers. Therefore, the villagers' dependence level on the upland forest is uncertain.

Research result show that Awak Pah village has more choices than that of Eirke village based on the responses given on dependence level upon the forests. When asked what they would do if they are unable to use the upland forests 100 per cent of the households in Eirke replied they would return to the lower land area. As for the Awak Pah village, forty two percent of the interviewed households suggested they pass onto their children to cultivate, and they would cultivate other crops (each activity possess twenty-one percent respectively). Twenty eight percent stated they would look for job, and would cultivate in the lowland area (each future option has 14 percent). Seven percent said they would go into fishing, while seven percent would retire from being just farmers and seven percent did not respond. The research result suggests that Awak Pah village has more diversed future options compared to that of Eirke village. The percentage breakdown of future options for Awak Pah is shown in the following table.

Table 4: Future Options

Awak Pah Village Future options	Count	Percentage
Cultivate in low land=1	2	14%
Children will cultivate=2	3	21%
Cultivate other crops=3	3	21%
Look for job=4	2	14%
Retire=5	1	7%
Fishing=6	1	7%
No response	1	7%

Current Management of the Upland Forests

When asked about the current management of the upland forest, fifty-six percent of the households interviewed are not satisfied, while thirty-three percent are satisfied and eleven percent did not give any comments. The majority of the villagers are not satisfied for the following reasons.

The majority of the household members interviewed have concerns on the use of the upland forest use in the future. Their major concerns constitute the following: forty percent perceive deforestation as the major concern, twenty-two percent of the interviewed households are concerned with water pollution; and population growth eleven percent. Four percent believes the future use of the forests lies within educational awareness workshops, which would emphasize the importance of keeping the forests untouched. Unproductive crops due to deforestation, uncertainty on future generations use of the forests; and decrease in soil fertility and decrease in the number of streams are also major concerns. Four percent of the households believe these will limit the use of the forests in the future.

Table 5: Villagers' Major Concerns on the Future Use of the Forests

Major Concerns	Percentage
Deforestation	40 %
Water Pollution	22%
Importance of forest	7%
Education Awareness	4%
Population growth	11%
Unproductive crops	4%
Uncertainty on future forest use	4%
Decrease in streams	4%
Soil fertility	4%

For both villages, Awak Pah and Eirke, planting kava occupies the majority of the villager's time (97 per cent). In Eirke 100 per cent of the households interviewed plant kava in the upland forests. As for Awak Pah, only three percent of the interviewed households, cultivate kava in the upland forest. The remaining households (97 percent) plant and cultivate in the lowland areas. This however, does not mean that Awak Pah villagers do not make any forest clearings, which causes deforestation. The research result show that other activities in the upland forests are: bird hunting, deer hunting, wild pig hunting and search of new land. These activities occupy lesser amount of time of the villagers' time compared to that of kava planting. This strongly suggests that kava planting is the major activity generating pressure upon the upland forests resulting in deforestation. Research result indicates other things which include the following: 1) hunting of wild pigs, deer and birds is becoming less. This could mean that their population is decreasing. As more and more kava growers and hunters move upland, hunting of these wild animals become popular leading to their decrease in population which could result in more detrimental stage impacts such as species becoming severely stressed and eventually endangered.

Decline in Forest Resources

A study conducted Raynor (1996) suggested that hunting of birds, namely the Micronesian Pigeon (*Ducula oceania*) and the Caroline Islands ground dove (*Gallicolumba kubaryari*) was popular in the past among Pohnpeians. Over-harvesting has caused dramatic population decrease. Hunting has increased from the following: population increase coupled with availability of rifles and introduction of cash market for some species. Raynor also noted that poaching is common, while enforcement is weak. There is existing legislation protecting the Micronesian Pigeon, but people still hunt them (Raynor, 1996).

The effect of hunting is not limited to the Micronesian Pigeon. Coastal and off-shore island nesting seabirds, flying foxes, and other small forest birds, namely Micronesian starlings (*Aplonis opaca*) and Purple-capped Fruit Doves (*Ptilinopus Porphyraceus*) fall prey to hunters. The Pohnpei Lory or "Serehd" (*Trighoglossus rubiginosus*), the State bird is fully protected (Designation of State Bird SL No.2L-90-81) is seldom hunted even though numbers of this certain species appear healthy (Thomas, 1996).

In 1983 and 1994, the US Fish and Wildlife Service carried out a bird survey. This provided baseline data for observing and monitoring trends of bird population (Engbring et al., 1990). Mr. Don Buden of the College of Micronesia again conducted the 1983 survey in 1994. The US Fish and Wildlife Service is analysing

the survey result. The analysis would reveal changes in species population during the past 12 years (Thomas, 1996).

In 1995, the College of Micronesia, coordinated by Mr. Don Buden, conducted a questionnaire survey on deer population. The results were not conclusive due to the following: the understanding of the ecology and dynamics of the small deer population, nonetheless, they do provide valuable anecdotal information on hunting techniques, the venison or meat market, and a downward trend in numbers and an upward movement in hunting effort per animal killed (Thomas, 1996).

Overall, this particular research result in conjunction with Raynor's research result and other surveys provide valuable information on the status of the bird populations of Pohnpei and the impacts of habitat changes (from clearing to plant kava) and hunting pressures over the past 12 years. More importantly, based on what has been discussed, there is a major decline in non-timber forest products, as well as agricultural crops.

Searching for new land in the upland forest areas is common among kava growers. Land is very important to the kava growers as the soil is rich in nutrients, which would enable faster growth rate for the kava plants. Research result show that villagers could spent an average of 31 hours per month searching for new lands in the upland forests. This suggests that the commercialisation and the increased demand of kava has caused the kava growers to go upland where kava grows faster and search for new lands for further plantation and cultivation. As a result, this leads to deforestation in the upland forests.

In 1983, the USDA Forest Service and local foresters conducted an extensive vegetation survey. The survey result showed the area (24,789 hectares of forest land) has declined to an estimated of 19,683 ha or 55 per cent, and by 1995 to 16,.081 ha or only forty-five per cent of the island. Using the Intact Upland Forest category developed for the 1995 survey, only 15,000 ha (42 percent) of the island was covered in 1975 and this area has decreased dramatically to 5,162 ha, a fifteen percent by 1995 (Thomas, 1996).

Raynor (1994) suggested the following: Kava planting is the major cause of deforestation. Other causes include human settlement in the upland forest, tourist trails, economic development and so forth. However, discussion will only focus on the major threatening issue on the upland forest. Raynor's research study showed that kava plantations are major issues threatening the upland forest. This could conclude the case of Eirke and Awak Pah villages, where majority of the villagers have planted kava in the upland forests causing deforestation.

For the next section, brief discussion will be shown here to reveal other activities occupying the villagers' time and effort. In Eirke village, research result showed the majority of the villagers obtain woods from the upland forests mainly for constructing houses. As for Awak Pah village, the majority of the households interviewed obtain woods from the mangrove areas mainly for housing materials. This suggests that the two villages are located on different areas. For instance, Eirke is more in the upland and rural area, while Awak Pah is on the coastal area. This could reflect the different uses of construction materials by the two villages.

Research results reveal the following regarding major activities occupying the villagers both in Awak Pah and Eirke. These activities are taken place in the lower land areas. In both Awak Pah and Eirke, yam occupies most of the villagers' time (an average of 20 hours per month). In Eirke village, tapioca is the second major activity (occupying the villagers' time at an average of 20.50 hours per month); followed by swamp taro (16.78 hours per month). As for Awak Pah, banana ranks as second most major activity (6.30 hours per month), followed by breadfruit (6 hours per month).

One of the key strategies in addressing cultivation of kava in the upland forest is a Grow Low Campaign being carried out by The Nature Conservancy (TNC) and local partners. Through this effort, 1000 farmers, two high schools, three elementary schools and three commercial nurseries have set on a mission to cultivate over 1 million kava plants in the lowland areas (Kostka and Raynor, 2000).

The TNC also proposed to carry out biennial monitoring of forest clearing activity mainly to monitor the effect of the Grow Low Campaign and other factors of the kava strategy such as Community Planning Program, Community Conservation Officer Program, Watershed Forest Reserve boundary line survey and so forth. The objectives of the monitoring approach are to design a community-based monitoring program, which is both resource-efficient and practical and could be applied in management decision-making. The monitoring approach mainly focused on forest clearings. This was pioneered by TNC in 1998 in two forest areas, Senpehn, Madolenihmw, and Eirke, Nett (Kostka and Raynor, 2000). Findings of the survey included the following: 1) data collected can be used to get the general trends in forest clearing; 2) data collected can identify households need more attention by Community Chiefs, CCO, and staff members of the Watershed Project; 3) there are differences in new forest clearing activity between areas where the Watershed Program has been active and those where the Watershed Program has not yet begun (Kostka and Raynor, 2000).

For the purpose of this research, discussion will only reveal results from Eirke, Nett and U. The monitoring approach shows the following about Eirke with regard to forest clearings. 1) According to the survey taken in April 2000, the total number of clearings in Eirke is 36, and as of U there are 16 forest clearings. 2) The total area cleared for Eirke is assessed at 30.58 Ha, an average clearing size of .58, and U at 27.20 Ha, an average clearing size of 5.44. 3) Forest clearings caused by kava cultivation in Eirke is 86 per cent, kava and agroforest products are 8 per cent, and agroforest only is 6 per cent. As for U, 56 per cent of forest clearings is caused by kava cultivation, 0 per cent by kava and agroforest products, 13 per cent by agroforest products only, and 31 per cent are abandoned. The findings suggests the following: forest clearings caused by kava made up 71 per cent of all clearings, and those with kava combined with agroforest products (mainly breadfruit, bananas, and other food crops) made up 75 per cent of all clearings. Refer to the table below for data results. This reveals that kava cultivation is by far the major motivation for clearing the upland forest. The result suggests that most growers are producing kava for commercial purposes or markets. The overall abandoned plots is probably due mainly to survey error – some surveyors did not know data on abandoned plots should have been collected or gathered (Kostka and Raynor, 2000). Overall, the data suggests that the Grow Low Campaign is most successful where the village leaders support the

program and a clear connection is made between growing lowland kava and moving out of the forest.

Table 6: Forest clearings

Location	Total clearings	Total area cleared (Ha)	Average clearing size (Ha)	Kava only	Kava and Agroforest	Agroforest only	Abandoned
Eirke	36	30.58	.58	(31) 86 %	(3) 8%	(2) 6%	(0) 0%
U	16	27.20	5.44	(9) 56 %	(0) 0%	(2) 13%	(5) 31%
Total	52	57.78	6.02		8%	19%	31%

Source: Kostka and Raynor, 2000

As for the other activities taken place in the upland forest, village members hunt these wild animals for both subsistence survival and sometimes sports. As demand for kava increases, villagers were inclined to search for new land in the upland forests. This suggest that cultivation of kava is the major cause of deforestation in Pohnpei.

Community Members' Dependence on Forest Products

There are three major ways of hunting in Pohnpei, namely shooting, use of breadfruit sap and traps.

Rainfall in Pohnpei is generally well distributed throughout the whole year. January and February appear to have slightly less rain. The majority of the interviewees confirmed that they hunt birds by shooting, especially when it is wet. This is due to birds being less alert. In addition, the majority prefer hunting birds early in the morning. The village members use slingshots and rifles.

Breadfruit saps are used in hunting birds. The villagers normally collect saps from breadfruits. The use the sap to trap birds. They generally use the sap during fruit bearing season. They would set the sap on banana shoots and so forth.

Traps are designed for wild pigs, deer and chickens. Bigger and stronger traps are used for wild pigs and deer. These traps are like fence, which require careful construction and target. The traps for chickens are smaller and other hunting tools used are strings and coconut meat (as bait). Dogs are also used to hunt wild pigs, deer and chicken.

The majority of the households interviewed stated the following concern regarding the wildlife that they depend on. The population of birds has decreased which could result from loss of forest cover and increase in hunting.

Forest Products

Non-wood forest products constitute significant roles in both villages of Eirke and Awak Pah. The non-timber forest products provide them the subsistence level of survival, despite most of the non-wood forest products do not enter the market. It is difficult to quantify their market values. The non-timber forest products are classified

into three major categories namely, aquatic and wildlife animals, herbal medicine, and construction and fuel materials. Results are given in Tables 1.7(a), 1.7(b), and 1.7(c)

Table 7(a): Monthly Quantities of Non-timber Forest Products - Wildlife and Aquatic Animals

Item	Unit	Total Q.	Average Q.	Min	Max	Std dev
Bird	head	115.00	14.38	5	20	5.63
W. Deer	Kg	285.00	71.25	65	75	4.79
W. Chicken	head	121.00	8.07	5	12	2.55
W. Pig	Kg	1115.00	159.29	90	250	59.33
Fish	Kg	545.00	41.92	28	63	12.82
Shrimp	Kg	80.00	13.33	10	18	2.73

Table 7(b): Monthly Quantities of Non-timber Forest Products - Construction and Fuelwood

Item	Unit	Total Q.	Average Q.	Min	Max	Std dev
Firewood	Bundles	1473.00	64.04	20	120	32.34
Woods	Stem	738.00	35.14	6	100	18.67

Table 7(c): Monthly Quantities of Non-timber Forest Products - Herbal Medicine

Item	Unit	Total Q.	Average Q.	Min	Max	Std dev
Medicine	Plant	96.00	6.86	4	20	4.55

Table 7(a) shows total monthly quantities (for the 27 households interviewed) and the average monthly quantities (per household) of wildlife such as deer, pig, bird and chicken. Deer, for instance, is caught at a total annual quantity of 285 kg by the 27 interviewed households. Each household may get an average of 71.25 kg per year. The standard deviation is greater than zero indicating the distribution may not follow a normal pattern. This may be due to small number of households hunting for deer (i.e. in this case, of the 27 households, only seven hunted for deer). Wild pigs are hunted 159 kg per year by 27 households interviewed.

Fish, shrimp

Eirke and Awak Pah villages depend on different places to catch their sources of protein such as fish and shrimp. Eirke depend on the river for fish source, while Awak Pah relies on the ocean. This coincides to the location of the two villages. Eirke is in the rural upper land, while Awak Pah is in the coastal area. Fresh water and sea fish, along with shrimps are part of the villagers' diet. As shown in table 1.7(a) each household is estimated to catch an average of 13 kg of shrimp and 41 kg of fish per year. Both villages prefer fish than shrimp. The reasons being fish has more meat and bigger. Both villages expressed that the population of fish and shrimp has decreased. They are not as abundant as before.

Wild pig, wild deer and chicken

All of these wildlife animals are trapped by fence traps. In addition, chicken is also caught by rope traps and bait (coconut). Wild pigs weigh an average of 40 kg, and they are commonly used for family consumption. Chickens are also consumed by villagers, weighing an average of 1.5 kg. Some Pohnpeians when they use local medicine for spiritual protection, refrain themselves from eating chicken. Pigs and deer are the only wildlife animals sold in the markets. Deer weigh an average of 60 kg.

Firewood and other woods

Firewood is referred to as anything that can be burnt such as small branches and chopped wood. They do not have timber value. Firewood is used daily mainly for family consumption, specifically for cooking breakfast, lunch and dinner. It is collected in bundles both by men and women. It may take from 30 minutes to 2 hours each time to collect firewood. The time to collect firewood depends on availability of firewood and the distance from home. Some may collect on daily basis, while others may spend up to half a day for 3 to 6 months use.

Ais trees grow tall to a height of 80 to 100 feet (25-30 m). They bear large, round reddish-brown fruit 2-3 inches (6-8 cm) in length. The hard wood is not resistant and is commonly used in constructing houses. This is true especially where mangrove trees are not available, and this is what Eirke villagers rely on for building houses.

The *katar* trees grow to a height of 25 to 30 feet (8 to 10 m), with a black, thick and fibrous trunks that have soft inner core. The inner core of *katar* is durable, and can remain in the soil for as long as 20 years before rotting. They are commonly used in building houses in Pohnpei. Pohnpeians also use the trunks of *katar* to support commercial black pepper vines (*Piper nigrum*) and for fence posts. The *katar* population has drastically decreased due to population growth, increase demand for housing materials and pepper plantation.

Fruits

Kirek en wel (*Eugenia stelechantha – Myrtaceae*). The edible fruits of this tree of Pohnpei is smaller but is similar to those of its close botanical relative, Apel (Eugenia malaccensic). *Apel* is also edible. *Nihn*, the native fig tree also has edible fruits. Kotop (*Clinostigma ponapensis*)is a source of food and medicine. It is used by hunters in the upland forest as food, the heart of the palm. There is a well-known story about the light-colored flowering parts of *kotop*. Warriors that came from Kosrae spotted many palms in flower in the mountains as they approach the island of Pohnpei. They mistook the light-colored flowering stalks as men's skirts made from *keleu* (*Hibiscus, tiliceus*).

These are the major edible fruits in the upland forest. They are only collected and consumed when hunters or farmers visit the upland forest. Consumption is dependent upon availability and visits by farmers or hunters. Overall, these are used for village members' consumption. They are not traded or sold in the markets.

Herbal medicine

Medicine is collected by both men and women from the forests, as well as the lowland areas. Herbal medicine is significant within both villages. The village members claim medical treatment at the Pohnpei State Hospital being expensive, however when they pay tribute (known locally as ilisapw) for their herbal medicine treatment, it is far more expensive. It takes a total of eight days to treat a sick person with local herbal medicine. In worst cases, it may take up to a month. The payment process involves paying after every four days. For the first ilisapw, the sick person would bring kava and other food items to the local doctor. The value of the items presented with ilisapw could be USD$50.00. The length of treating diseases depend on the seriousness of the sickness. A total of eight plants could mix together to treat a

sickness. In each village there are quite a number of local doctors. Table 8 reflects the names of common herbal medicines and their treatments.

Table 8 Herbal Medicines and Treatments

Pohnpeian Names	Medical Treatment
Kurum	Skin disorder
Kamal	Magical medicine
Keleu	Cure
Kotokotasahu	Restores memory
Liwekidenlol	Cure heartbroken
Pisetikmei	Cure shingles, use to increase children's appetite
Remek	Cure womb illness
Wihnmar	Relieve pain after birth
Wei pwul	Treat diabetes
Sei en wai	Treat coughing
Apwid	Treat ear infection
Topwuk	Treatment for various skin diseases
Rehdil	Use for healthy development in young children

Villagers' Major Use of the Upland Forest Resources

When asked about how the villagers use the upland forest products, ninety percent use the products for sale and sixty-three percent for family use. These results show that the major uses are for sale and family. None of interviewed households trade or exchange their products for any other goods or services. Selling of the product takes place in the markets (70 percent), an in other places (22 percent). Other people may order, or the villagers sell their products at the public schools or to the Pohnpei State Hospital. Seven percent sometimes sell their products within the village. These are reflected in the tables given below.

Table 9(a): Major use of the Forest Products

Use	Total	%age
1 Trade	0	0%
2 Sale	25	93%
3 Family	17	63%
4 Other	0	0%

Table 9(b): Trade places

Trade place	Total	Percentage
Market	19	70%
Neighborhood	0	0%
Within village	2	7%
Other	6	22%

When selling their products, sixty-three percent of villagers use a taxi service as a source of transportation. Twenty-two percent of the villagers own private cars, and 4 per cent use privately owned boats. It costs an average US$2.33 the farmers when they take a taxi to sell their products. There are additional costs (an average or US$4.30) are placed on their products. This additional cost is faced by fifty-nine percent of the farmers or villagers. It takes an average of 1.45 hours for the villagers to take their products to the markets and return. It is quite close by. These are reflected in the tables given below.

Table 10(a): Transport to market place

Transport	Total	%age
Foot	0	0%
Taxi	17	63%
Own car	6	22%
Boat	1	4%
Other	3	0%

Table 10(b): Transport Cost and Time

	Count	Mean	Min	Max	Std
Transport cost	17	2.12	2	4	0.49
Time to market hrs	25	1.48	0.5	4	0.80
Additional costs	19	0.84	0	1	0.37
Extra costs	16	2.81	1	20	4.65

Value of Forest Resources for Eirke and Awak Pah Villages

There are major difficulties associated with valuation of forest products (actual monetary value of each good sold). Community members do not sell all the forest products, they consume them as well. This is indicated from the feedback given previously. The majority of the households stated their dependence on forest products for both cash and family consumption. The value of the forest products are calculated using weighted average price based on responses given by the households. The weighted average price is calculated to value the total quantity of forest products.

The values of the non-timber forest products to the local community of Eirke and Awak Pah are calculated with the application of weighted average unit price. Table 11 shows that forest products contribute at least US $9,262.00 to the villagers per month. This is based on the actual prices that villager get when selling their non-timber forest products. As reflected in the table, construction and fuel wood do not show any values. They are not sold in the markets, as they are only used by community members. This does not mean that they do not possess any economic value. Wildlife alone contributes US$ 2,134.00 per month and kava generates $7,128.00 per month to the villagers of Eirke and Awak Pah.

Table 11: Total Estimated Value of Forest Products to Eirke and Awak Pah Villages

Items	Herbal medicine and Kava	Aquatic & Wildlife Animals	Construction & Fuel woods	Total of NTFP
US$ Dollars	$7,128.00	2,134.00	Important but not estimated	$9,262.00
Percentage	77%	23%	-	100%

Other Sources of Income and Agricultural Products

In addition to the income generated from forest products discussed previously, each household earns an average additional income of US$2961.00 per month as per the result given for question 24 (which excludes the monetary value of agricultural crops). This cash income is earned by salary as taxi drivers, construction workers and

so forth. Multiplying the figure above by the total number of households (i.e. 55) gives US$162,894.30, which is the additional cash income for Eirke and Awak Pah per year (excludes forest products).

The monetary value of agricultural production for each household is approximately US$ 11,781.00. This is calculated based on information given in question 7. The average quantity is calculated by multiplying the average market price of agricultural product sold.

Overall, there are three major sources of income for Eirke and Awak Pah villages. These include monetary revenue earned from non-forest products, income from agricultural production and other salaries. These are reflected in the following table.

Table 12: Estimated Total Annual Income by Village and Household

Sources of Income	Eirke and Awak Pah Villages	Per Household	Total Income (Percentage)
NTFP	$9,262	$168.39	34%
Agricultural crops	$11,781.00	$214.00	44%
Other	$6,033.12	$109.12	22%
Total	$27,076.12	$491.51	100%

Table 12 shows that out of the total annual revenue of US$ 27,076.12 generated by the two villages, forest products contributes (34%), agricultural products (44%) and other sources of income (22%). This shows the following: 1) the two villages depend heavily on the forests to plant kava for fast cash, which is not a sustainable use of the forest; 2)

CONCLUSION

From this research study, some major conclusions could be drawn.

1) Pohnpei's forests should be protected and preserved for the following reasons: a) the forests provide various non-timber forest resources that play important values to the villagers, if they are not managed, they will eventually be destroyed; b) non-timber forest products play important role in the villagers' subsistence level of survival; c) conservation of the forests could also mean preservation of culture. Preserving culture is the foundation of promoting sustainable forest management; and d) there are also environmental benefits such as biodiversity, watershed protection and so forth, hence the forests need to be preserved.

2) The local indigenous villagers have knowledge on forests and non-timber forest products based on their dependence and experience. If the traditional management system is properly used with relevant contemporary management systems, Pohnpei's forests can be managed sustainably. This is due to local villagers who have been living in the area for generations. They know better than anybody else on how the forests can be managed. Sustainable management can be achieved in the presence of traditional management system from the local people.

LIMITATIONS

There are limitations of this research study. The research is conducted using Eirke and Awak Pah villages. The results could be subjective as the information was obtained by households based on their memories and own perceptions of their use of the forests, life, concerns and needs. Valuation of non-timber forest products only focused on direct use. One could say the values of non-timber forest products were under-estimated, because watershed protection and biodiversity and so forth were not included.

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PRODUCTIVITY MEASUREMENT FROM MULTI SPECIES PROJECTS

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Abstract

Much attention is focused on conservation efforts to recover species listed as threatened or endangered. As part of these efforts, many projects attempt to manage sites containing populations of multiple threatened or endangered species. The evaluation of such projects is essential to determine their success and cost effectiveness in the recovery of threatened and endangered species. . In this paper, we report on the further development of the Cost Utility Analysis (CUA) technique, previously tested on single species programmes, to the evaluation of multi species projects. Tests on six New Zealand conservation projects reveals the CUA technique can determine the success and cost effectiveness of a range of different multi species projects. The four sites that contain a high proportion of the total population of a threatened species produced the most output in terms of the recovery of species. The Present Value cost per unit of output ranged from $325 000 to more than $20 million. This research finds little evidence that multi species projects are more cost effective than single species programmes in the recovery of threatened and endangered species. These multiple species projects may, however, have other outputs, such as advocacy or ecosystem restoration, which are included in their objectives and are, as yet, unmeasured. The versatility of the CUA technique provides further support for its use both in New Zealand and internationally for the evaluation of both single species programmes and multiple species projects.

Key words: Threatened species, management, success, cost effectiveness.

INTRODUCTION

The recovery of threatened and endangered species is costly. Annual expenditures on threatened species programs are US$20 million in New Zealand (DOC 2001a), US$280 million in the United States (Dawson and Shogren 2001), and $6 billion globally (James et al 1999). James et al. (1999) estimated that global expenditures of $22.6 billion per annum will be needed to protect 15 percent of global land area as natural reserves. The case for expenditures of this magnitude is predicated upon the belief that they will be both sufficient and effective in preventing biodiversity loss. Whether support for the first requirement is justified is dependent upon the success and cost-effectiveness of species recovery efforts. This is largely an empirical question, but one that is rarely tackled despite the often very large expenditures already occurring.

While much attention has focused on single-species projects and programmes, increasing interest and effort has been directed toward multi-species projects. Multi-species projects can spread expenditures over several species and may provide a lower cost way to manage threatened species than do single species projects and programmes. That possibility can be tested by measuring the success and cost effectiveness of multi-species projects, and comparing those measures to the results for single-species projects and programmes.

For expenditures on threatened and endangered species to be successful, they must produce some output in terms of the recovery of species. There is, however, very little tangible evidence available showing that expenditures on threatened species projects are successful. A fundamental issue to be confronted is how to measure the output produced by threatened species projects. A recent paper considered this problem and concluded ...'It was not possible to find an unbiased, objective metric for measuring effort put forth in recovery actions and to track relative success. At this time, in fact, many recovery management actions cannot be determined to be successful or unsuccessful' (Abbitt and Scott 2001: 1281). We report in this paper on the Cost Utility Analysis (CUA) technique we have developed to measure effort put forth in recovery actions, and to track the relative success of those actions.

CUA has been applied in some earlier studies to single species projects (Cullen et al 1999; Cullen et al 2001). In this paper we demonstrate how CUA has been further developed to align the measurement scale with the internationally usable IUCN Threat Categories. We report how we apply the technique to multi-species projects and provide empirical results on the relative success of six New Zealand multi-species projects in preventing biodiversity loss. Those results are subsequently compared to similar measures for single species programmes to determine whether multi-species projects provide lower cost recovery of species.

EVALUATION OF THREATENED SPECIES PROJECTS

Many researchers, including biologists, economists and others have tackled evaluation of threatened species projects. A recent survey of this literature is provided by Hughey et al (2002), who outline the wide range of approaches applied to evaluation of biodiversity protection. A major conclusion of that survey is the absence of comprehensive empirical evaluations of real world biodiversity protection projects. Much evaluation literature written by economists focuses on hypothetical projects including how to maximize habitat selection with a finite budget. The evaluation literature written by biologists focuses on population numbers, genetic uniqueness and other biological features, but neglects the contribution that can be made from economic analysis.

Our focus is on success and cost effectiveness of threatened species projects. Managers of New Zealand biodiversity projects are required to be cost effective in preventing, and mitigating the causes of biodiversity loss (DOC 2001b).

Determining success and cost effectiveness requires quantifying the inputs used, and the outputs produced by these projects. The quantity of inputs used in threatened species projects can be measured using data on the costs of inputs. Measurement of costs requires care in identifying the appropriate costs to include, but so long as there are adequate accounting records for projects, this is a straightforward task. Measurement of outputs produced by biodiversity projects appears more complicated, but is achievable. Our focus is on the conservation status of threatened and endangered species, compared to a counterfactual of their conservation status in the absence of the project.

Cost Utility Analysis (CUA) was developed more than thirty years ago to overcome a similar challenge in evaluation of 'human health projects' (Drummond et al., 1997). Projects have goals, and the contribution of projects can be measured by the extent to which they achieve their goals. Human health projects have proximate goals - overcome infection, suture the wound – but the overarching goal is to improve human health. Progress toward the goal can be described on a scale from 0.00 (death) to 1.00 (complete health). CUA is used to evaluate health projects by comparing patient's health status with medical intervention, to a counterfactual, what their health status would have been without medical intervention (Drummond et al 1997). In these studies the counterfactual typically is 'no change' in health status.

Biodiversity projects also have proximate goals – reduce the numbers of predators, increase the area of habitat – but the overarching project goal is improvement in the conservation status of a species. CUA aims to measure projects success in achieving the overarching goal. Cullen et al. (2001) demonstrate how CUA has been adapted to quantify the success of New Zealand biodiversity projects in improving the conservation status of single species. The majority of the projects studied by Cullen et al (2001) are single species projects. In this paper we report on how we have improved the measurement of output, and demonstrate how output can be measured from multi species projects.

The CUA approach measures output produced in biodiversity protection projects by comparing the 'with project' status of a species over time, to the 'without project' status of the species over time. The contribution of a project, positive or negative, is the summation of any difference in the species' status 'with project' and the species status 'without project'. Projects that successfully improve a species status over time, when the base case would have been no change in species status, or more frequently, decline in species status (DOC/MFE 2000; Abbitt and Scott 2001), will deliver significant quantity of output. Projects that do not improve a species' status from their 'without project' status, do not deliver any output. Biodiversity protection projects may have several goals, including improvement in the status of selected species. Other goals of biodiversity projects can include protection and restoration of ecosystems, generation of information from research into species management, predator and pest control, and advocacy and education functions. We recognize that several goals may be pursued in biodiversity projects, and obtain information on progress toward each goal for each project. We argue that improvement in species' status is a major goal and in this paper report primarily on evaluation of projects against that goal.

METHODS

A key requirement of the CUA technique is an appropriate scale for measuring species conservation status. Many countries and institutions have developed scales to describe species status (Molloy and Davis, 1994; USFWS, 1990; IUCN, 2000). These scales attempt to apply a set of well-defined criteria to determine the status of any species. In practice, many of these approaches place each species in a status category such as 'Endangered', 'Threatened', 'Near Threatened'. This is a categorical approach to describing species status. The New Zealand Department of Conservation (DOC) recently developed a new categorical threat classification scale (DOC 2001a). The scale is linked to the recent IUCN (2000) scale, but recognizes some unusual features of New Zealand species and ecosystems, particularly their relatively small habitat area, and their small carrying capacity population numbers.

Our objective is to quantify the output produced by projects and we use a combined categorical and cardinal scale to describe species status. We require species and project managers to describe species status on a continuum from 0.00 (Extinct) to 1.00 (Not Threatened). A notable feature of the scale we use is the linkage to categories on the DOC (2001a) species classification system. A second notable feature is the non-linear nature of the scale. The scale is quadratic, and a species status score increases at a diminishing rate as the species moves closer to 1.00 (No Threat). This use of a quadratic scale explicitly awards greater marginal benefit to improvement at the lower end of the scale than at the upper end of the scale, consistent with the widely recognized phenomenon of diminishing marginal benefits from actions. Use of a continuum from 0.00 to 1.00 allows for much greater precision in describing the status of species, than is possible with seven categories. This is a major advantage as the status of most species

changes gradually, and these small changes can be recorded on the continuum, but are typically hidden if a categorical system is used.

Project and species managers were asked to provide annual data on threatened species' status over the life of the project, 'with project', and 'without project', using the 0.00 to 1.00 continuum . We sum the yearly ('with project' minus 'without project') scores to calculate the total output from the project. Our unit of measurement is Conservation Output Protection Years, COPY (Cullen et al 1999, 2001). For each threatened species present at the site, the contribution of the project is measured using the following equation.

$$COPYi = \sum_t \frac{(S_{tw} - S_{tw/o})}{(1+d)^t} \qquad (1)$$

Where:
S_{tw} is species' i conservation status in year t with management
$S_{tw/o}$ is species i conservation status in year t without management
d is the discount rate

For multi species projects, we add the numbers of COPY produced for each threatened species identified by the manager, to calculate the total output from the project.

$$\text{Total Output} = \sum_i \square\square\square\square_i \qquad (2)$$

Project planners/managers were sent a letter outlining the research project, and the technique to be used, a month before we visited them to obtain data on costs and species status. All project managers were interviewed at least once, using a structured interview approach, between December 2001 and March 2002. DOC recently completed classification of all New Zealand listed threatened species using its new threat classification system (DOC 2001a). Project planers and managers have access to that data and are well informed of the status of the species found at the site they manage. In several instances where widely distributed species were present on a site, the site managers were unable to provide 'with' and 'without project' scores for a species. In those instances we obtained data from the national species manager of the species. Information on the project costs was obtained from the project managers, and they could access that information for the Department of Conservation financial reporting system.

THE CONSERVATION PROJECTS

The New Zealand Biodiversity Strategy released in March 2000 provides a twenty-year plan to halt the decline in New Zealand's indigenous species. New Zealand has about 1300 threatened and endangered species. By way of comparison there are 1258 species listed as either threatened or endangered in the United States – see http://endangered.fws.gov/wildlife.html#Species. The Biodiversity Strategy is funded by an additional NZ$187 million of government expenditure over its first five years DOC (2001b). By way of comparison the US Fish and Wildlife Service estimated the potential direct costs from the recovery plans of all listed US species were about $4.6 billion, or about $2 million for each species (USFWS 1990). Conservation of New Zealand's native plants and animals is one of the country's main environmental issues (DOC and MFE 2000), a view supported by the World Economic Forum (2002) finding that New Zealand's biodiversity performance is ranked worst of 142 nations.

New Zealand biodiversity has suffered from the introduction of hundreds of exotic plant and animal species that predate, and out-compete many of the native and endemic species (Towns et al 1997). Programs to control or eradicate introduced species are vigorously pursued to reduce the threats faced by many indigenous species. As well, several offshore islands, which are free of predatory species, are used as sanctuaries for threatened species. In some cases small numbers of threatened species have been translocated to pest-free offshore islands as either temporary, or long term habitats (Kanze 2000). This strategy uses the surrounding sea to provide a barrier to reinvasion by pest species. One obvious limitation to this approach is the number of pest-free offshore islands available in New Zealand waters.

An alternative approach, Mainland Islands (MI) has been developed during the past fifteen years (Saunders, 2000). The Department of Conservation has designated six sites as Mainland Islands, and relies upon fences, topography, trapping and poisoning to control the numbers of pests at these sites. Four features are said to distinguish Mainland Island projects (Saunders 2000): they have ecological restoration goals; they involve intensive, multi-pest control programs; detailed monitoring of the projects is undertaken; and they are expected to have relatively high costs and risks, as well as high returns. Mainland Island are likely to be more costly than offshore islands as they do not have surrounding sea to provide a free, natural barrier to predators and competitors. Mainland Island projects have greater reporting requirements, and hence more information is available on them than occurs for offshore islands.

Offshore islands and Mainland Island often provide sanctuary to multiple threatened species, and expenditures at these sites are likely to benefit multiple species (Cowan, 1992; Towns et al., 1997). In some instances the threatened species managed at these sites may be umbrella species (Andelman and Fagan, 2000), and a number of other species can benefit from expenditures targeted at one species. The challenge is to determine the output produced at these sites where multiple species are expected to benefit.

Three of the sites are offshore islands and three are Mainland Islands. All projects have several threatened species present and are directed at improving the status of those multiple species, as well as other project goals. In three projects threatened species have been translocated to the island or Mainland Islands for temporary or permanent sanctuary. Legislation allows species to be introduced to Nature Reserves and Scientific Reserves but only allows re-introductions of species into National Parks. Table 3 reports the Present Value of expenditures over the life of the project at four discount rates, and their annualized costs per hectare. Noticeably, the three projects with smallest areas have costs per hectare twenty times greater than do the three larger projects. Tiritiri Matangi, the smallest area, costs sixty times more per hectare per year than does Hurunui, the largest area.

Not all expenditures at these sites are directed at improving the status of threatened species. Five of the six sites have a goal of protection and restoration of the ecosystem. Five of the projects have a goal of endangered species conservation, and the sixth, Rotoiti, has a goal of community restoration. At three of the sites, some expenditure is for public education and advocacy purposes. Projects can be evaluated in terms of their range of goals. Our research measures the projects success and cost-effectiveness in terms of the recovery of species. We recognize the range of goals of projects when commenting on their relative success and cost effectiveness.

RESULTS

Our principal goal is to measure the success and the cost effectiveness of the threatened species expenditures at these six sites. We use CUA to evaluate progress towards a goal of improvements in species' status. Table 1 reports the contributions from each of the threatened species present, and the total numbers of COPY produced, at each of the six sites. There are remarkable differences between projects in measured output produced. Explanations for these differences in measured output produced include variations in project life, proportion of the species' total population managed at the site, position of each species on the status continuum, lifespan of the species, and the barriers to improvements in species status. Notably, the Little Barrier Island, Maud Island, Hurunui and Mackenzie Basin projects have operated for ten or more years, include a large proportion of the total population of at least one short lifespan threatened species, and the first three of those projects have achieved significant progress with at least one threatened species. In contrast the Tiritiri Matangi and Rotoiti projects provide habitat for small fractions of the total population for each threatened species present, and the projects have as yet made little progress in improving those species status compared to their counterfactual status. Recovery of species often takes many years, but the Rotoiti project has been in operation for only five years.

It is well understood in New Zealand, and increasingly in other countries (Doerksen et al 1998; Abbitt and Scott 2001; Fish and Wildlife Service 1990), that real species management projects incur significant annual management costs. Table 2 lists the management costs of each of the six projects, measured in New Zealand dollars. These costs do not include habitat purchase costs that are the focus of many North American studies (Montgomery et al 1994, 2000, Hyde 1989, Polasky et al 1999). All six New Zealand projects are sited on state owned land, and legislation prevents the land being available for other activities. There are no opportunity costs for the sites in the annual costs, but they do include an annual capital charge of 10 percent. All costs have been converted to 2001 dollars using the Statistics New Zealand Producers Price Index, All Industries. Each of the projects requires significant annual expenditure to plan, reduce pest numbers, monitor species, threats and other activities.

These projects require major investments each year and we can calculate the relative productivity of each investment by comparing measured output produced, to the size of the total investment. Table 2 reports Present Value of costs of each project, and PV per COPY. There is a relatively small range in Present Value of the investments, but the wide variation in numbers of COPY produced at the six sites plays the major role in determining the relative productivity of the projects. The Little Barrier Island project is the most successful project. It is largely responsible for maintaining the Stitchbird in the Range Restricted category, when the counterfactual is steady decline in its status. Maud Island is the second most successful project and makes major contributions through the protection it provides for the Maud Island frog and Stephens Island gecko. Hurunui MI makes a major contribution to the management of Orange Fronted parakeet. Project River Recovery provides management for the world's rarest wading bird, the black stilt. The black stilt faces a myriad of threats and progress is very slow in improving its status. As well as Project River Recovery, a Black Stilt programme also manages this species and much of the Black Stilt's progress has been attributed to that programme.

DISCUSSION

The results presented in Tables 1, 2 indicate that five of the six projects studied have contributed to the management of threatened species, either through improving species' status or preventing decline in their status. A maximum of three threatened species per site, benefited from a project. The contribution of each project to threatened species management is measured by summing the COPY produced for all known threatened species at each site.

Managers of the sites we studied were asked if there were umbrella species present, and they reported at least one umbrella species present at each site. However few of the species sheltering under an umbrella are on the Threatened Species list. We have measured the COPY produced by the project for all threatened species at each site. By definition, other species including those who might benefit from expenditures on umbrella species, are not threatened, hence any improvements in their status will be of minor importance. Increases in population numbers of those species may provide utility to humans, who enjoy seeing more of them, but the expenditures do not contribute significantly to the species' status. Although we have measured the status of only a few

of the array of species at each site, the total COPY produced provide a valid indication of the overall contribution of each project to threatened species management. This result is of considerable importance as it greatly reduces the information required for evaluation of multi species projects.

The PV/COPY reported in Table 2 can with caution, be compared with the PV/COPY reported in Cullen et al (2001: Table 7). Cullen et (2001) use a quadratic function to measure output from programmes, but their measurement scale is based on seven species status categories rather than a continuous scale as used in the present research. The impact of using the seven-category scale is reduced likelihood that the projects will produce output, and reduced cost effectiveness of the programmes. Recognizing those caveats, it is notable that eight single species programmes (Cullen et al 2001: Table 4), have greater success (mean COPY of 1.12) than do the six multi-species projects we have studied (mean COPY 0,79). Their mean cost effectiveness ratio (cost per COPY) is $645,482, less than 10 percent of the mean cost per COPY for the five multi species projects which have measured output ($7,548,326 per COPY). We find no evidence that multi-species projects have a cost effectiveness advantage over single species programmes in the recovery of endangered species. The expectation that Mainland Island projects will have relatively high costs and returns (Saunders 2000), is only supported by the data on costs. The three Mainland Islands have mean annualized cost of $317,734, double that of the three offshore islands ($158,094). However the three Mainland Islands are much less successful (mean COPY 0.57) than the three offshore islands (mean COPY 1.84), and much less successful than the eight single species programmes in Cullen et al (2001) (mean COPY 1.12).

Our analysis focuses on measurement of the productivity of the projects at threatened species management. We repeat that management of threatened species is not the sole objective of the six projects. CUA of the six projects provides illuminating information on the relative productivity of the projects we studied. Rotoiti Mainland Island project has produced zero COPY and has an undefined cost/COPY. Three projects Little Barrier, Maud and Hurunui, have a PV/COPY of less than $1.5 million. Each of these projects manages a significant proportion of the total population of at least one threatened species. Tiritiri Matangi and Rotoiti projects by comparison, manage only small proportions of the total populations of the threatened species present. Tiritiri Matangi has a cost per COPY more than fortyseven times greater than the cost per COPY for Little Barrier Island, and over 500 times greater than the cost per COPY of the most cost effective single species programme in Cullen et al (2001). This result occurs because of the high costs of the project and the small contribution to species progress achieved at Tiritiri Matangi.

CONCLUSION

Measurement of success and cost effectiveness is essential to evaluate the merit of biodiversity projects. We have shown how success and cost effectiveness can be measured for multi-species projects using a Cost Utility Analysis approach. Measurement of output from six projects is accomplished by way of a species conservation status continuum linked to the DOC and IUCN threat classification scales. Project experts provided data on species' conservation status, and costs of the projects, at six multi species sites. Comparison of each species conservation status to a counterfactual their without project conservation status, allows calculation of project success measured in numbers of COPY produced. The focus on threatened species present, greatly simplifies the information collection problem for evaluation of multi species projects.

Three sites, each with high percentage of at least one threatened species present, achieved greatest success. Sites lacking a high percentage of at least one threatened species contribute little or nothing to species conservation. The six projects vary greatly in area, and in expenditures per hectare. Their annualized costs range from $81,000 to $509,000, but their cost effectiveness varies by a factor of at least forty-five. Multi-species projects may benefit several species, but only for threatened and endangered species does this contribute to measured success. This research finds no evidence that multi-species conservation projects are more cost effective than are single species programmes. Mainland island projects are more costly, and less productive than are offshore island, and single species programmes.

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Table 1: Output from each project, numbers of COPY

Project River Recovery	0%	6%	Maud Island	0%	6%
Black Stilt	0.07	0.04	Maud Island Frog	1.21	0.80
Wrybill Plover	0.00	0.00	Stephens Island Gecko	0.87	0.57
Black Fronted tern	0.10	0.06	Giant Weta	0.30	0.17
Robust Grasshopper	0.28	0.17	Kakapo	0.00	0.00
Total COPY	0.45	0.27	Wood pigeon	0.00	0.00
			Total COPY	2.38	1.54
Hurunui					
Yellowhead	0.14	0.11	Little Barrier Island		
Great Spotted Kiwi	0.00	0.00	North Island Saddleback	1.05	0.72
Orange Fronted parakeet	1.04	0.84	North Island kokako	0.55	0.29
Yellow Crown parakeet	0.10	0.08	North Island tuatara	0.00	0.00
South Island Kaka	0.00	0.00	Stitchbird	1.39	0.81
Mistletoes	0.00	0.00	Total COPY	2.99	1.83
Total COPY	1.28	1.04			
			Tiritiri Matangi		
Rotoiti			Takahe	0.09	0.05
South Island kaka	0.00	0.00	Little Spotted Kiwi	0.00	0.00
South Island robin	0.00	0.00	Brown Teal	0.00	0.00
Yellow Crowned parakeet	0.00	0.00	Stitchbird	0.06	0.03
Mistletoes	0.00	0.00	North Island kokako	0.00	0.00
Total COPY	0.00	0.00	Total COPY	0.15	0.08
Mean COPY	0.570.43		Mean COPY	1.84	1.15

Table 2: Cost and Cost Effectiveness of Projects Discount Rates (%)

Project	0	3	6	10
River Recovery				
PV of Costs	$5,133,758	$4,519,029	$4.021,954	$3,496,535
Annualized cost			$509,581	
Annualized cost/ha			$46.33	
PV per COPY	$11,408,351		$14,415,605	
Hurunui				
PV of Costs	$1,04,6271	$953,945	$874,605	$785,202
Annualized Cost			$156,672	
Annualized cost/ha			$13.05	
PV per COPY	$817,399		$840,966	
Rotoiti				
PV of Costs	$1,631,540	$1,514,120	$1,411,466	$1,293,618
Annualized costs			$286,951	
Annualized cost/ha			$347.81	
PV per COPY	undefined	undefined	undefined	undefined
Maud Island				
PV of Costs	$3,277,849	$2,632,676	$2,162,521	$1,717,890
Annualized Cost			$222,653	
Annualized cost/ha			$695.80	
PV per COPY	$1,374,360		$1,404234	
Little Barrier Island				
PV of Costs	$1,279,103	$994,657	$792,120	$605,666
Annualized Costs			$81,557	
Annualized cost/ha			$28.95	
PV per COPY	$427 794		$432,852	
Tiritiri Matangi Isl.				
PV of Costs	$2,347,206	$1,949,414	$1,651,838	$1,361,288
Annualized Cost			$170,073	
Annualized cost/ha			$780.15	
PV per COPY	$15,648,040		$20,647,975	

Economic transformation and agriculture: has New Zealand's comparative advantage shifted?

by

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ABSTRACT

In recent years, "economic transformation" has been touted as the means by which New Zealand can elevate itself into the top half of the OECD's rankings for living standards. Finding a clear definition of economic transformation is not easy, but it probably involves New Zealand moving away from basic primary production, and focusing more on high value-added processing and hi-tech manufactures. This paper examines whether or not economic transformation has occurred since the 1984 reforms. We use highly disaggregated export data to determine the sectors in which New Zealand had a comparative advantage in 1985, and how this has changed over time. One of our aims was to identify New Zealand's sectoral star performers, and those sectors which have struggled. The results provide an indication of how the New Zealand economy has changed in the last fifteen years, and offers an insight on the key question facing today's economic policy makers: where to next?

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1. BACKGROUND AND OUTLINE

NZIER and Treasury are both interested in explaining the long term growth performance of the New Zealand economy, and the prospects for economic transformation. While finding a broad consensus as to the exact meaning of economic transformation has proved difficult, we tend to agree with Skilling (2001, p. 3) that "economic transformation has entered into the popular lexicon rapidly. However, it has been defined in many different ways by various commentators, including different ministers, and there is no real consensus on a working definition. Broadly, however, it seems to relate to increasing the knowledge component of New Zealand economic activity and increasing the pace of innovation, with the idea of substantially improving NZ's economic performance". In other words it is used to represent a move away from a historical reliance on primary production towards an economy based on higher value-added, more technologically advanced goods.[1]

Previous work undertaken by NZIER (Briggs, Bishop and Fan, 2001; Ballingall and Briggs, 2001) has shown that:[2]

(i) Much of New Zealand's relatively weak economic growth can be attributed to low export growth.

(ii) New Zealand's low merchandise export growth is mainly due to the composition of exports – New Zealand's exports tend to be in sectors where growth in world imports has been relatively slow, such as agriculture, at an aggregate level.

These results, on the face of it, seemed to support the need for some form of economic transformation. In our earlier analyses we compared New Zealand's growth in export values with growth in world imports. In doing this we used a relatively high level of aggregation; we basically worked at the Standard International Trade Classification (SITC) 1-digit level.[3] This work showed little evidence of any economic transformation occurring in the New Zealand economy. However, due to working at a high level of aggregation, it is possible that we may have overlooked fast growing sub-sectors. Such sub-sectors may be in more technologically advanced, higher value-added areas, and could boost export growth substantially in the future, yet in our earlier analysis their effects on growth were going unnoticed.

With this in mind, we decided to conduct a more detailed examination of New Zealand's export structure – using data to the SITC 4-digit level of aggregation. We focused on the period between 1985 and 1999, looking at 'snapshots' of New Zealand's export structure in each year, and at how this structure has changed over the 15-year period covered. Policy changes over the last 20 years provide a natural experiment to examine issues of comparative advantage. The reduction in export subsidisation and import protection since the 1970s has increasingly exposed the tradeable sector to world market conditions – revealing the characteristics of New Zealand's comparative advantage more clearly.

The aims of the study were threefold:

1. To show in which areas New Zealand's share of world trade is high, thereby identifying areas of revealed comparative advantage in each year.
2. To examine how New Zealand's comparative advantage patterns have changed over time – has there been any noticeable signs of economic transformation? For example, have the primary processing sectors gained in competitiveness since 1985?

[1] For various viewpoints on economic transformation, see the twelve Treasury discussion papers online at http://www.treasury.govt.nz/et

[2] Both papers are available on the NZIER website http://www.nzier.org.nz

[3] At the SITC 1-digit level, there are only ten aggregate sectors, see http://reportweb.usitc.gov/commodities/naicsicsitc.html for a full listing.

3. To identify fast growing sub-sectors that may contribute strongly to New Zealand's export – and thus GDP – growth in the future.

In effect, this work is an update of the work done in the 1991 Porter study, which looked at New Zealand's export sectors at a low level of aggregation. The study identified sectors such as boatbuilding and electric fence manufacturing as fast growing export industries which could represent future avenues of growth and prosperity for New Zealand.

The paper is organised as follows: Section 2 provides the theoretical background to the project and explains the methodology used; Section 3 presents a summary of the key results from the analysis; and Section 4 gives some conclusions and suggestions for further work.

2. THEORETICAL CONSIDERATIONS

2.1 The theory of comparative advantage – a quick refresher course

Classical trade theory explains trade patterns using Ricardo's concept of comparative advantage.[4] The law of comparative advantage says that each country exports those goods and services which it produces at a relatively low opportunity cost, and imports those goods which it produces at a relatively high opportunity cost. A country's comparative advantage is in part determined by its endowment of resources (land, labour, capital, energy, etc). For New Zealand, fertile soil and a favourable climate have led to a comparative advantage in primary products such as dairy, meat, forestry, and horticulture. The development of management techniques and technological advances that are specific to agriculture have further enhanced our comparative advantage in such sectors. Our relatively low energy costs (based on hydroelectricity) also give us a comparative advantage in the production of basic metals and energy-intensive primary processing. Comparative advantage is also distorted by trade barriers such as tariffs and quotas, and by situations of imperfect competition. As such, a country's comparative advantage can change over time as these distortions are reduced, and as resource endowments alter. In New Zealand, the reforms since the mid-1980s, including unilateral and multilateral trade liberalisation, have exposed New Zealand producers to international competition, and highlighted New Zealand's areas of comparative advantage and disadvantage.

2.2 Measuring comparative advantage

Comparative advantage as a concept to explain patterns of trade is widely accepted. However, directly measuring a country's true comparative advantage in a particular commodity is difficult if not impossible. Attempts have therefore been made to approximate the comparative advantage concept in an indirect way. These indirect methods use information derived or "revealed" from post-trade situations and assumptions.

Broadly following the methodology in Porter (1990) and Crocombe *et al* (1991), we define a sector to have a comparative advantage if New Zealand's share of world exports in that sector exceeds a threshold percentage, where this threshold is New Zealand's total exports as a percent of total world exports.[5] To estimate the extent of a sector's comparative advantage, we calculate the revealed comparative advantage (RCA) index for each sector in 1985 and 1999. This technique stems from Balassa (1965), and the index for each year is estimated using the following formula:

$$RCA_{ik} = 100 * \left[\frac{X_i^k}{X_w^k} \Big/ \frac{X_i}{X_w} \right] \qquad \text{Equation (1)}$$

[4] See, for example, Sodersten and Reed, 1994.

[5] Also see footnote 6.

where X = exports

k = commodity

i = country (always New Zealand in our study)

w = world

This ratio is greater than 100 when a country's share of world exports for a particular commodity is greater than the country's share of total world exports. A value over 100 indicates that the country has specialised in this commodity – it has a comparative advantage.

By calculating the RCA index for 1985 and 1999, we create two snapshots of New Zealand's export structure. We also look at how each sector's RCA has changed during the period. Changes in RCA between periods 0 and 1 can be measured as follows:

$$RCA_i^0 = \frac{X_{ik}^0}{X_{wk}^0} \Big/ \frac{X_i^0}{X_w^0} \qquad \text{Equation (2)}$$

$$RCA_i^1 = \frac{X_{ik}^1}{X_{wk}^1} \Big/ \frac{X_i^1}{X_w^1} \qquad \text{Equation (3)}$$

$$\Delta RCA_{ik} = 100 * \left[\frac{RCA_{ik}^1}{RCA_{ik}^0} - 1 \right] \qquad \text{Equation (4)}$$

Through these formulae we can calculate the relative share of country i's exports of commodity k in the first time period (equation 2); the relative share of country i's exports of commodity k in the second time period (equation 3); and the ratio of the share of country i's exports of commodity k in the second period to that in the first period (Petersen and Gounder, 2002). A positive number suggests that a sector has increased its comparative advantage between the two years.

In addition to employing the RCA measure, we also look simply at compound annual growth rates of New Zealand and world exports in each sector, in order to examine where New Zealand exporters are gaining in market share.

2.3 Limitations of the RCA approach

The analysis presented here using RCA does not – and indeed cannot – attempt to explain *why* New Zealand's comparative advantage has changed over time. Such explanations require a far more in-depth microeconomic analysis of each sector's unique structure, relative costs, and domestic and world market conditions. Rather, this work aims to identify *how* New Zealand's export structure has changed, and whether there has been a shift away from primary products towards high value-added, 'knowledge economy' type goods.

This analysis does not examine changing comparative advantage in the service sector. This is primarily due to a lack of internationally comparable data on services. However, it must be acknowledged that in recent decades, many countries have concentrated on becoming more service-oriented. If New Zealand's exports of services were included in this analysis of comparative advantage, it is likely that sectors such as tourism and tertiary education would have become much more prominent in recent years.

It has been argued that because the RCA index is constructed in a way such that it is not symmetric (that is, in our formula, the RCA can range between 0 and infinity, but with a midpoint of 100) it may not be suitable for econometric analysis (Laursen, 1998). Interested readers may also wish to look at Vollrath (1991) for a critique of the RCA measure. Despite

the perceived shortcomings of the RCA, it is a useful tool for examining comparative advantage in a simple way.

2.4 Data summary

We obtained from the United Nations' COMTRADE database the following data for 1985 and 1999 at the SITC 4-digit level of aggregation:

- New Zealand's exports to the world.
- New Zealand's imports from the world.[6]
- All reporting countries' exports to the world.[7] The data was summed over these reporting countries to create a 'world' exporter category.

Note that all data collected was from the Revision 1 classification of the SITC codes. This enabled us to get the widest coverage of sectors and reporting countries. There are 706 sectors at the 4-digit level of aggregation. All data was delivered in nominal $US. Since we are looking primarily at relative growth rates and relative market shares, it is not necessary to delate the nominals. Care should be taken, however, when looking at absolute changes in exports.

3. SUMMARY OF KEY RESULTS

It is not practical to present in this paper a full set of results for all 706 commodities covered by the report.[8] After performing our analysis, we were faced with thousands of numbers, and determining the most concise and meaningful way to present the results proved to be a challenge! The following is a summary of we saw as the key results and more interesting changes.

3.1 Where do we stand now?

We start this summary be looking at the structure of New Zealand's exports in 1999. Just to show that sometimes economic theory and economic reality do align, Figure 1 shows that New Zealand tends to export more in those sectors in which it has a comparative advantage.

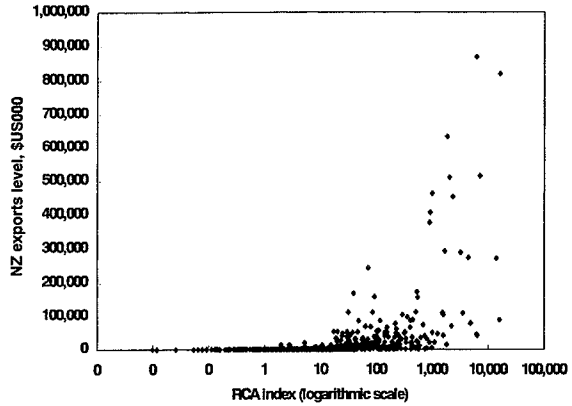
[6] We obtained import data because the Porter study (Crocombe *et al*, 1991) uses an additional criterion to identify a sector with comparative advantage: If imports exceed exports in a sector, that sector will be regarded as having no comparative advantage, unless its share of world exports is more than twice the threshold percentage. However, our calculations showed very few sectors that have an export share greater than average export share *and* have imports exceeding exports.

[7] Note that in 1985, there were 113 reporting countries. In 1999 there were 126. It could be argued that because the number of countries reporting increased over the period, we may have overstated world growth. However, by identifying which countries were present in 1999, but not in 1985, it was found that there was only one major exporter missing in 1985: China. Data from the IMF's *International Financial Statistics* publication (2001) shows that in 1985, China's exports to the world were $US27.33 billion, approximately the same as Switzerland's exports in that year. This compares to total world exports in 1985 of $US1,623 billion. In 1999, China's exports had grown to $US195.15 billion. We did not adjust the world total in 1999 to remove China's exports, as their rapid export growth suggests that they have taken some market share from other countries. Of the other countries missing in 1985, the majority are small African nations, and former Soviet republics. None of these countries had exports large enough to skew our results significantly.

[8] The full results can be obtained from the corresponding author.

Figure 1 Comparative advantage and export levels 1999

Revealed comparative advantage index (x-axis). Exports in $US000s (y-axis)



Source: COMTRADE, NZIER

With 706 sectors to analyse, it is easier to look at the broad results in 1999 by aggregating up to the 1-digit level. Table 1 clearly shows how New Zealand's comparative advantage remains firmly in the production of food and live animals.

Table 1 Comparative advantage by 1-digit sector in 1999

Commodity group	Commodity name	Number of 4 digit sectors	Sectors with comparative advantage	Comparative advantage as % of total in that commodity group
0	Food & live animals	101	37	36.6
1	Beverages and tobacco	11	2	18.2
2	Crude materials excl fuels	120	25	20.8
3	Mineral fuels	17	1	5.9
4	Animal, vege oil, fats	22	4	18.2
5	Chemicals	74	11	14.9
6	Basic manufactures	199	37	18.6
7	Machines, transport eqpmt	91	8	8.8
8	Other manufactured goods	66	8	12.1
9	Other	5	1	20.0
	TOTAL	706	134	19.0

Source: COMTRADE, NZIER

So how does our sectoral comparative advantage look today? Table 2 shows the top thirty goods in which New Zealand has a comparative advantage, ordered by magnitude of the RCA index.

Table 2 Top thirty commodities in which New Zealand has a comparative advantage in 1999

Commodity code	Commodity name	NZ exports to the world (US$000s) in 1999	RCA index in 1999 >100 shows a revealed comparative advantage
0112	MUTTON ETC FRSH,CHLD,FRN	819,529	16,347
2117	SHEEP SKIN WITHOUT WOOL	89,328	15,972
2622	WOOL DEGREASED	271,975	14,093
0230	BUTTER	514,457	7,147
2512	MECHANICAL WOOD PULP	42,294	6,364
2911	BONES,IVORY,HORNS,ETC	45,567	6,293
0222	MILK AND CREAM DRY	868,958	6,160
0118	MEAT NES FRESH,CHLD,FRZN	78,594	4,877
0514	APPLES FRESH	273,574	4,457
2621	WOOL GREASY,FLEECE-WSHED	109,654	3,537
2422	SAW-,VENEER-LOGS CONIFER	288,880	3,212
5995	STARCH,INULIN,GLUTEN,ETC	452,392	2,328
0015	HORSES, ASSES, MULES	70,714	2,223
0240	CHEESE AND CURD	509,752	2,024
0111	BOVINE MEAT FRESH,FROZEN	631,579	1,846
2112	CALF AND KIP SKINS	15,127	1,819
0519	FRESH FRUIT NES	292,861	1,687
2919	ANIMAL MATERIALS NES	104,288	1,582
4113	ANIMAL OIL ETC,EXCL LARD	42,251	1,581
6416	FIBREBOARD OF WOOD ETC	110,616	1,522
0116	EDIBLE OFFAL FRESH,CH,FR	47,040	1,247
6130	FUR SKINS TANNED,DRESSED	21,247	1,098
6512	YARN OF WOOL,ANIMAL HAIR	50,603	1,005
0311	FISH FRESH,CHILLED,FROZN	461,991	994
6611	LIME	4,776	986
6841	ALUMINIUM,ALLOYS,UNWRGHT	406,410	918
2432	LUMBER SHAPED CONIFER	377,144	896
0619	SUGARS AND SYRUPS NES	20,882	891
2119	HIDES AND SKINS NES	3,571	806
4312	HYDROGENATED OIL,FAT	33,032	792

Source: COMTRADE, NZIER

Of these thirty sectors, the majority are based on primary production:

- Five are concerned with animal hides, fur, and leather.
- Five are directly based on sheep (mainly wool, plus mutton).
- Three are sectors producing dairy products.
- Four are related to wood, pulp and paper products.
- Two are based on horticulture.
- Four are general agricultural sub-sectors (honey, meat extracts, offal, other animal products).
- One is fresh, frozen or chilled fish.
- Two are focused on fats and oils.
- One is starch, inulin, gluten, etc.
- One is sugars and syrups not elsewhere specified.

There are only two sectors that are not based on agriculture or forestry industries: lime and unwrought aluminium alloys.

3.2 What's changed since 1985?

There are a number of ways at looking at the changes in sectoral growth and comparative advantage that have occurred between 1985 and 1999. A quick and easy way to compare export structures in 1985 and 1999 is to replicate Table 2 for 1985. This is shown in Table 3.

The similarities between Table 2 and Table 3 are remarkable. While products have moved up and down the list since 1985, the overall flavour of both tables is the same – the sectors in which New Zealand has the largest comparative advantage are based on sheep, dairy, wood products, horticulture and basic metals.

Table 3 Top thirty commodities in which New Zealand had a comparative advantage in 1985

Commodity code	Commodity name	NZ exports to the world (US$000s) in 1999	RCA index in 1999 >100 shows a revealed comparative advantage
2117	SHEEP SKIN WITHOUT WOOL	152,514	16,408
0112	MUTTON ETC FRSH,CHLD,FRN	577,506	15,383
2622	WOOL DEGREASED	417,137	11,817
2512	MECHANICAL WOOD PULP	53,357	4,643
0230	BUTTER	331,352	4,587
2621	WOOL GREASY,FLEECE-WSHED	279,377	3,703
0222	MILK AND CREAM DRY	272,087	3,277
5995	STARCH,INULIN,GLUTEN,ETC	143,294	2,348
0111	BOVINE MEAT FRESH,FROZEN	460,862	2,111
0519	FRESH FRUIT NES	131,618	2,094
0116	EDIBLE OFFAL FRESH,CH,FR	44,339	1,917
0514	APPLES FRESH	53,992	1,807
2919	ANIMAL MATERIALS NES	49,839	1,651
0470	MEAL AND FLOUR NON-WHEAT	13,311	1,556
4113	ANIMAL OIL ETC,EXCL LARD	57,384	1,462
6318	WOOD SIMPLY WORKED NES	33,796	1,334
0015	HORSES, ASSES, MULES	36,856	1,305
0914	MARGARINE,EDIBLE FAT NES	15,514	1,092
0118	MEAT NES FRESH,CHLD,FRZN	10,161	1,090
6841	ALUMINIUM,ALLOYS,UNWRGHT	243,605	1,047
0240	CHEESE AND CURD	131,735	1,000
6512	YARN OF WOOL,ANIMAL HAIR	45,906	947
2911	BONES,IVORY,HORNS,ETC	4,372	909
6971	DOMESTC STOVES,OVENS,ETC	22,135	867
0311	FISH FRESH,CHILLED,FROZN	151,706	834
6566	BLANKETS,COVERLETS ETC	7,015	817
0546	VEGETABLES SIMPLY PRESVD	20,790	807
0536	FRUIT TEMPORARILY PRESVD	8,764	783
2112	CALF AND KIP SKINS	7,503	761
0313	SHELL FISH FRESH,FROZEN	99,883	681

Source: COMTRADE, NZIER

A further way to examine how New Zealand's export structure has changed over time is to examine the sectors in which New Zealand has lost or gained a comparative advantage since 1985. Table 6 in Appendix A shows which sectors had a comparative advantage in 1985, but not in 1999, and those which did not have a comparative advantage in 1985, but which did in 1999.

Table 6 shows that since 1985, New Zealand has lost its comparative advantage in a number of agricultural goods, forestry and wood products, glass manufactures and basic metal manufactures. It is likely that New Zealand's competitors in some of these markets are able to produce these goods on a much larger scale, thus gaining economies of scale, being more efficient and having a much lower per unit cost than New Zealand.

On the other hand, New Zealand has gained a comparative advantage in a wide range of sub-sectors since 1985. It is important to consider the level of New Zealand's exports in each of these sub-sectors, in order to determine how likely that sector is boost New Zealand's export growth in the future. The sub-sectors in which New Zealand has gained a comparative advantage *and* are of significant size are:

- Food preparations not elsewhere specified. This sub-sector includes tea and coffee, mustards, sauces and seasonings, soups and broths, yeast and vinegar ($US104.5 million of New Zealand exports in 1999).
- Wine ($US77.3 million of New Zealand exports in 1999).
- Newsprint paper (US$87 million).
- Coal, excluding briquettes ($US38.6 million).
- Hydrogenated oils and fats ($US33.0 million).
- Coal and petrol distillates not elsewhere specified ($US36.4 million).
- Washing preparations ($37.6 million)
- Pesticides and disinfectants ($US61.6 million).
- Other bulk paper, not elsewhere specified, which includes greaseproof paper, corrugated paper, rolled paper, coated paper, and wallpaper ($US65.8 million)
- Paper articles not elsewhere specified, which includes cigarette papers and copying paper ($US29.8 million)
- Various types of iron and steel, alloys, and fencing wire.
- Agricultural and harvesting machines.
- Metal transport boxes ($US27.6 million)
- Medical instruments not elsewhere specified ($US54.7 million).

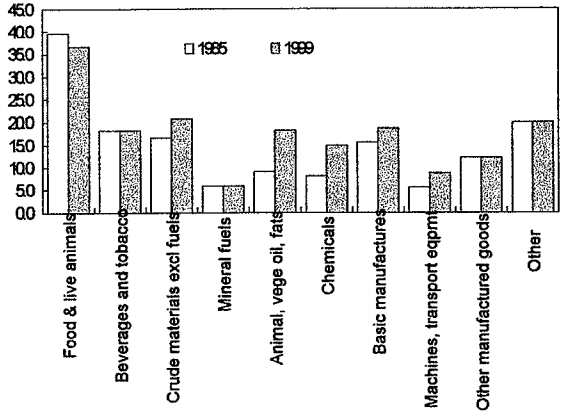
The rest of the sub-sectors in which New Zealand has gained a comparative advantage since 1985 are relatively unimportant in terms of their contribution to overall exports.

So what does this analysis imply about the degree of economic transformation that has occurred in the New Zealand economy since 1985? Figure 2 shows the proportion of sub-sectors in the 1-digit aggregations that have a comparative advantage, for 1985 and 1999. At an aggregate level, it portrays the change in New Zealand's comparative advantage over time.

Economic transformation in this diagram would be shown by the height of the bars on the left hand side of the chart decreasing, with bars towards the right increasing – showing a shift in comparative advantage from food and live animals to elaborate, higher value-added processed or manufactured goods. It suggests that while some sub-sectors are starting to gain comparative advantage in industries other than food and live animals, our focus remains on

primary products. The two sectors showing the largest change are animal and vegetable oils and fats, and chemicals.

Figure 2 Changes in NZ's comparative advantage
Percent of 4-digit sectors that have comparative advantage in each 1-digit aggregation



Source: COMTRADE, NZIER

3.3 Identifying future avenues of growth

One of the aims of this research was to identify fast growing sub-sectors that may contribute strongly to New Zealand's export growth – and thus GDP growth – in the future. Can we spot the 'star performers' of the future? We are particularly interested in is those sectors in which:

1. New Zealand export growth is higher than world export growth – we're gaining world market share.
2. World growth is above average world export growth – it's a dynamic, fast-growing sector in world markets.
3. New Zealand has a comparative advantage – we're good at producing in this sector. From Figure 1 we know that a sector that has a comparative advantage is likely to be of reasonable size.

We start by looking at New Zealand export growth and world export growth by sector. Table 4 shows thirty sectors where New Zealand's export growth has been larger than world export growth (that is, New Zealand exporters are gaining market share). Note that these are compound annual growth rates.

Table 4 Top thirty sectors where New Zealand export growth has been stronger than world export growth

Commodity name	New Zealand growth less world growth, per year	New Zealand exports in 1985, $US000s
IRN,STL COIL FR REROLLNG	96	2
AIRCRFT HEAVIER THAN AIR	78	16
VEG USED IN PHARMACY ETC	69	1
HYDROGENATED OIL,FAT	66	14
STEAM ENGINES,TURBINES	62	3
LEAD,ALLOYS UNWROUGHT	52	9
WHITE SPIRIT,KEROSENE	51	3
COAL,PETR DISTILATES NES	50	80
CAMERAS STILL,FLASH APP	47	5
HORMONES	44	3
WASTE OF WOOL AND HAIR	44	7
LINSEED OIL	41	1
IRN,STL THIN COATED NES	39	212
IRN,STL MEDIUM PLATE ETC	38	7
WATCHES,MOVEMENTS,CASES	36	15
DEVELOPED CINEMA FILM	36	19
FUSES,PRIMERS,DETONATORS	35	5
DISTILLATE FUELS	35	26
AIRCRAFT ENGINES INC JET	33	64
LIME	32	56
LORRY,TRUCK,BUS CHASSIS	32	6
LORRIES,TRUCKS	32	40
INORG CHEM PRODUCTS NES	31	49
CALF LEATHER	31	8
SLAG,SCALINGS,DROSS,ETC	31	62
RADIO BROADCAST RECEIVRS	31	13
RADIOACTIVE ELEMENTS ETC	30	2
ACCTING MACHS,COMPUTERS	30	7
HORSE MEAT FRSH,CHLD,FRN	30	23
FUEL WOOD AND WASTE	31	6

Source: COMTRADE, NZIER

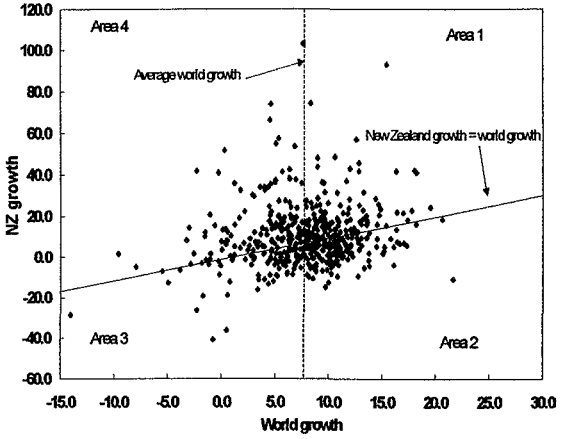
In the vast majority of the thirty sectors in Table 4, there has been rapid New Zealand export growth from a very low base in 1985, as shown by the right hand column of the table. Hence these sectors do not account for a large proportion of New Zealand's overall exports. This is an example of where looking at export *growth* rates alone can be misleading. We also need to consider the *levels* of exports in terms of their contribution to New Zealand's overall exports.

In addition to knowing which New Zealand sectors are gaining market share, we want to know if the sectors in which New Zealand is growing faster than the world are growing faster than average world growth. That is, are these the sort of sectors that we really want to be in? This question is considered diagrammatically in Figure 3.

Figure 3 is a scatter plot of New Zealand growth by sector against world growth by sector. There are two key things to note:

- Any point to the right of the vertical dashed average world growth line means that that world exports in that sector are growing faster than average world export growth.
- Any point above the "New Zealand growth = world growth" 45° line means that New Zealand's exports in that sector are growing faster than world exports in that sector (i.e. they are gaining market share).

Figure 3 NZ export growth versus world export growth
Compound annual growth, 1985 to 1999

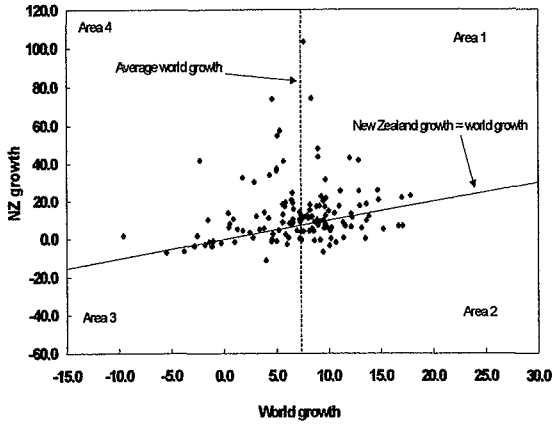


Source: COMTRADE, NZIER

Therefore any point in Area 1 indicates a sector in which New Zealand export growth is greater than world growth and world growth is above average world growth. We are now close to identifying New Zealand's star performers over the last 15 years, as these sectors are gaining market share in dynamic world markets. However, we also need to know how important these sectors are to total New Zealand exports. As shown in Figure 1, the degree of comparative advantage is a reasonable proxy for the size of the sector.

Therefore, we now recreate Figure 3, but plot only those sectors in which New Zealand has a comparative advantage. The combined export value of the sectors in which New Zealand has a comparative advantage in 1999 is $US9.6 billion, or around 78% of total New Zealand exports.[9]

Figure 4 NZ's star performers
World growth (x-axis), New Zealand growth (y-axis), compound annual growth rates



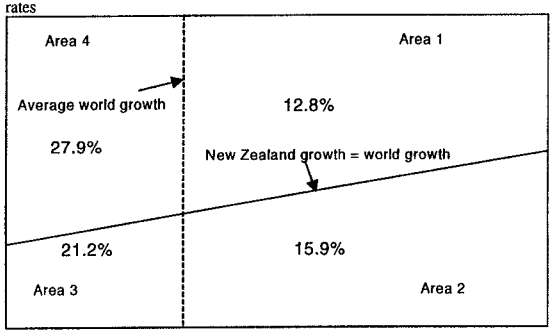
Source: COMTRADE, NZIER

The star performers are those which are to the right of the dashed average world growth line, and above the 45° line on which New Zealand growth equals world growth. In each of these 37 sectors, New Zealand exporters have been able to use their strong comparative advantage to latch onto sectors that are performing well in world markets. In addition, they have been able to grow more quickly than the world sector – they have gained in market share.

It is interesting to determine what proportion of New Zealand's total exports are in each area in Figure 4. These proportions are shown in Figure 5.

[9] According to the law of comparative advantage, *all* of New Zealand's exports should be in sectors in which New Zealand has a comparative advantage. However, as noted in section 2.1, this law is derived under conditions of immobile factors of production, perfect competition, and completely free trade. Since these assumptions are violated in the real world, trade patterns will not be entirely determined by comparative advantage.

Figure 5 Proportions of New Zealand's exports in each area
World growth (x-axis), New Zealand growth (y-axis), compound annual growth rates



Source: COMTRADE, NZIER

Looking at the two areas to the left of the average world growth line, nearly half of New Zealand's total exports in 1999 were in sectors in which world exports are growing slower than average world export growth.

It is useful to now look at the sectors in each area in more detail, bearing in mind that the definition of each is somewhat crude. It also needs to be remembered that the situation presented in Figure 4 is ever changing. The dynamic nature of the world economy means that some sectors are likely to move between the four areas of the diagram, especially those clustered around the intersection of the average world growth line and the 45° line.

3.3.1 Area 1: Star performers

These are sectors in which New Zealand has a comparative advantage, in which New Zealand's exports are growing faster than world exports, and which are fast-growing world markets. In total, there are only 37 sectors in Area 1. The 37 sectors can be broadly grouped into the following categories:

- Horticultural products – including cereal preparations, fresh apples, jams and jellies, potatoes, dried vegetables, seeds and cut flowers.
- Wine
- Other food products – including fresh milk and cream, tinned fish, sugars and syrups.
- Wood and paper products – including plywood, reconstituted wood, fibreboard, chemicals from wood, resin, and other paper articles.
- Metal products – including coated, thin iron and steel, iron and steel coils and rough forgings, worked copper and aluminium alloys, and metal storage and transport boxes.
- Miscellaneous – including hydrogenated oils and fats, washing preparations, fuses, primers and detonators, safety glass, agricultural and other non-electrical machines, medical instruments, baby carriages, and zoo animals and pets.

The combined export value of these 37 sectors is $US1.6 billion, relative to New Zealand's total exports of $US12.4 billion. This represents around 13% of New Zealand's total exports. So none of these sectors are particularly massive at this point in time. However, the total world export value of these sectors (that is, the potential market for these products) is $249.9 billion, so there are massive opportunities for these firms. Table 5 provides some summary data on these sectors.

Table 5 New Zealand's star performers

Commodity code	Name	RCA index	New Zealand export level in 1999, $US000s	World export level in 1999, $US000s	New Zealand growth	World growth
0223	MILK AND CREAM FRESH	690	74,370	4,443,745	17.5	12.9
0320	FISH ETC TINNED,PREPARED	226	48,231	8,794,339	8.9	8.7
0488	CEREAL ETC PREPS NES	339	32,732	3,985,208	21.7	17.0
0514	APPLES FRESH	4457	273,574	2,531,700	12.3	7.9
0533	FRUIT,JAMS,JELLIES ETC	437	8,519	804,011	17.4	9.1
0541	POTATOES FRSH EXCL	222	9,737	1,806,003	10.1	8.9
0545	OTHER FRESH VEGETABLES	508	113,330	9,192,553	13.6	10.5
0551	VEG DRIED EXCL LEGUMES	218	5,208	983,139	11.6	8.3
0619	SUGARS AND SYRUPS NES	891	20,882	966,962	11.5	7.7
0990	FOOD PREPARATIONS NES	294	104,455	14,668,011	17.4	11.0
1121	WINE OF FRESH GRAPES ETC	218	77,334	14,658,966	31.6	9.7
2411	FUEL WOOD AND WASTE	110	896	336,184	43.0	12.0
2925	SEEDS,ETC FOR PLANTING	624	35,506	2,347,120	11.0	8.0
2927	CUT FLOWERS,FOLIAGE	284	31,308	4,553,549	12.3	9.7
4312	HYDROGENATED OIL,FAT	792	33,032	1,720,336	74.1	8.3
5542	WASHING PREPARATIONS	165	37,565	9,398,344	25.4	11.1
5712	FUSES,PRIMERS,DETONATOR	107	797	306,285	43.7	9.0
5996	CHEMICLS FROM	255	6,403	1,035,881	11.6	8.4
6312	PLYWOOD	404	66,685	6,801,951	17.0	8.8
6314	IMPROVED,RECONSTIT	193	23,159	4,943,924	13.2	12.1
6416	FIBREBOARD OF WOOD ETC	1522	110,616	2,998,080	22.9	17.8
6419	OTHER PAPER ETC NES BULK	156	65,845	17,447,115	21.6	9.7
6429	PAPER ETC ARTICLES NES	100	29,774	12,272,921	14.8	10.0
6647	SAFETY GLASS	134	12,879	3,963,001	18.4	13.6
6727	IRN,STL COIL FR REROLLNG	140	40,674	11,988,367	103.1	7.6
6748	IRN,STL THIN COATED NES	142	51,103	14,888,180	48.0	9.0
6793	IRON,STL FORGINGS ROUGH	169	6,614	1,610,109	41.8	12.8
6822	COPPER,ALLOYS WORKED	154	51,733	13,813,499	15.2	8.2
6842	ALUMINIUM,ALLOYS	103	55,231	22,113,186	9.3	9.1
6921	MTL STORAGE,MF	164	5,643	1,417,995	18.1	8.2
6922	MTL TRANSPORT BOXES ETC	266	27,567	4,280,208	22.5	9.3
6986	SPRINGS AND LEAVES	103	6,519	2,618,274	25.4	12.9
7129	AGRICULTURE MACHINES	121	5,379	1,829,784	9.8	9.5
7196	NON-ELECT MACHINES NES	110	56,440	21,175,337	20.0	9.4
8617	MEDICAL INSTRUMENTS NES	101	54,715	22,385,021	20.7	14.7
8941	BABY CARRIAGES ETC	158	1,844	482,189	25.8	14.7
9410	ZOO ANIMALS,PETS	202	1,685	343,642	17.0	9.6

Note: Growth rates are annual compound growth rates

Source: COMTRADE, NZIER

3.3.2 Area 2: Potential stars

The New Zealand sectors in Area 2 have a comparative advantage, are in faster than average world growth markets, but are not yet growing as fast as world growth. It is these sectors that may be of most interest to policymakers, because if they can be helped to lift their export growth, they may become star performers. The 28 potential stars in Area 2 account for 15.9% of New Zealand's total exports, or $US2.0 billion. They can be broadly categorised into the following groups:

- Fish – including fresh, chilled and frozen fish and shellfish.
- Fruit and vegetables – including fruit temporarily preserved, vegetables simply preserved, and other fresh fruit.
- Other food and beverages– including natural honey, bread, biscuits and cakes, chocolate, and cider.
- Animal and vegetable products – including fertiliser, soaps, starches, and bovine leather.
- Paper and wood products – including cork manufactures, paperboard, correspondence stationery, and exercise books.
- Textiles/materials – including made-up canvas goods, blankets, and unknotted carpets. Note that all three of these sectors are negative growth sectors for New Zealand exports.
- Miscellaneous – including domestic stoves and ovens, domestic electrical equipment, headgear, and picture postcards.

More detailed information on these sectors can be seen in Appendix B.

3.3.3 Area 3: Strugglers

The New Zealand sectors in Area 3 have a comparative advantage, but are in slow world growth markets, and are also growing slower than world growth. An analysis of these sectors, and those discussed below in Area 4 conforms with the results from our previous work that "New Zealand's low merchandise export growth is mainly due to it having a composition of exports that is skewed towards the slower-growing sectors" (Ballingall and Briggs, 2001, p. 1). The combined exports of the 22 sectors in Area 3 account for $US2.6 billion, or nearly 22% of New Zealand's total exports in 1999. They can be broadly grouped into the following categories:

- Meat – including fresh and frozen beef and mutton, offal, and other dried, smoked and salted meat.
- Other food – including eggs, leguminous vegetables, meat or fish meal fodder.
- Animal products – including bovine and equine hides, sheepskins, and wool.
- Wood products – including mechanical wood pulp and simply worked wood.
- Oils and fats – including animal oil, and animal and vegetable waxes.
- Miscellaneous – including yarn of wool, animal hair, unwrought aluminium alloys, cultivating machinery, dairy farm equipment, and fur clothes and products.

More detailed information on these sectors can be seen in Appendix B.

3.3.4 Area 4: Cash cows and potential strugglers

The New Zealand sectors in Area 4 have a comparative advantage, and are growing faster than world exports, but are in slow growing world markets. In other words, New Zealand is very good at using its comparative advantage to grow rapidly in these sectors, but world trade in these commodities isn't expanding quickly. Those sectors that are close to the average world growth line could be termed cash cows as these are products that have a high market share in a mature market that is growing steadily, if not spectacularly. Those sectors that are closer to the 45° line could be labelled potential strugglers, as they are growing slowly in world terms and New Zealand is only just growing faster than world growth.

If the goal is to shift some of these sectors into Area 1 (Star performers), then this may occur more by good luck than good management. In the majority of these sectors, New Zealand cannot cause the world market to expand. Hence it is unlikely that these sectors will become more dynamic world markets in the short term.

It is interesting to note that many of New Zealand's traditional export groups (dairy, meat, wood and pulp, etc) are in Area 4. The 44 sectors in the area account for 28% of New Zealand's total exports, and can be grouped as follows:

- Meat – including horse meat, meat extracts and juices, and 'other' fresh, chilled, frozen, prepared and preserved meats.
- Dairy – including butter, cheese and curd, dried milk and cream, and evaporated and condensed milk and cream.
- Other food – including salted, dried and smoked fish, and 'other' fresh, dry vegetables.
- Coal (excluding briquettes)
- Hides – including calf and kip skins, tanned and dressed fur and skins, goat and kid skins, and 'other' leather, hides and skins.
- Wood, paper and pulp products – including conifer logs and lumber, waster paper, newsprint paper, and sulphate wood pulp.
- Animal products – including fine, uncombed hair, combed hair and wool, oils of fish and whales, waste of wool and hair, bones, ivory and horns.
- Chemicals – including salt, alcohols and phenols, prepared explosives, pesticides and disinfectants, and other inorganic chemical products.
- Fibres – including cordage and manufactures, and 'other' yarn.
- Basic metals – including unwrought and worked lead alloys, and iron and steel fencing wire.
- Miscellaneous – including coal, harvesting machines, developed cinema film, lime, and plumbing fixtures.

More detailed information on these sectors can be seen in Appendix B.

4. CONCLUSIONS AND FURTHER WORK

In Porter's 1991 study of New Zealand's exports, one conclusion drawn was that "New Zealand does have some areas... [which] provide leading edge demand for products, services, supplies and machinery. New Zealand firms can build on this world-class demand to succeed in new industries. Examples where this has already occurred include yachts, electric fencing and certain other agricultural inputs, and sporting equipment" (Crocombe *et al*, 1991, p. 159). The results presented in this paper suggest that pinning our hopes for growth and prosperity on such tiny industries is probably futile. There are no 'silver bullets' by means of economic transformation policies, whatever they may be. New Zealand's comparative advantage remains largely with agricultural, horticultural and forestry-based products.

This study confirmed our earlier research that suggested that New Zealand's slow export growth (and therefore economic growth) has been due to it having a composition of exports that is skewed towards slow growing world sectors. Nearly half of New Zealand's total exports in 1999 were in world sectors that were growing slower than average.

In order to improve New Zealand's economic growth, our study suggests that more emphasis should be placed on improving efficiency and encouraging innovation in the industries in which we already have a comparative advantage, rather than searching for solutions in industries in which New Zealand will not be competitive. In other words, let's continue to do what we do, but do it better and smarter. Levels matter just as much as growth rates. A small change in productivity in the dairy sector, for example, would lift New Zealand's level of exports far more than a large gain in efficiency in the electric fence manufacturing sector.

The search for high value-added and technologically advanced processes is a valid policy direction, but it must be applied to the appropriate sectors. Or, as the Porter study suggests: "The goal should not be to fund blue-sky 'high-technology' or 'key technology' research for its own sake, but to focus on research that can improve the competitive position of New Zealand industry" (Crocombe *et al*, 1991, p. 174).

Turning now to the results presented in Figure 4. The policy issues determining the potential for future success in each of the four areas in the chart are different. In general, there is not a lot that the New Zealand government can do for the firms on the left of the average world growth line. Due to New Zealand's relatively small presence in most world markets, no amount of domestic policy changes are likely to lift world growth rates. Rather, it could be suggested that these sectors would be best served by the New Zealand government pressing for further multilateral trade liberalisation via the WTO. The removal of existing trade distortions may allow world markets to grow more rapidly. If this were to occur, then some of the cash cows could shift right and become star performers.

Of particular interest to New Zealand's policy makers will be those sectors that are in Area 2 in Figure 4, where New Zealand has a comparative advantage, and the world sector is growing above average, but New Zealand is not yet growing as fast as the world sector. The aim of policy must be to help move sectors from Area 2 to Area 1 in Figure 4 – to increase the potential of these sectors in order to let them become star performers. Such policies could involve sector-specific export promotion and marketing strategies and assistance with research and development.

So where could this line of research move to next? One option would involve a detailed microeconomic study of the sectors in each of the four areas of Figure 4. This would look at the drivers of growth of each sector, and would aim to reveal if there were any commonalities between the sectors in each area. This could identify why New Zealand's stars and potential stars are succeeding in world markets. This would provide valuable insights for policy makers. Another option would be to conduct studies of sectors' RCA for bilateral trade flows. For example, in which sectors has New Zealand performed particularly well in Australian markets? This could help export promotion authorities such as Trade New Zealand to focus their funding on the sectors displaying the most potential.

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APPENDIX A

Table 6 Sectors losing or gaining a comparative advantage

Sectors that have lost their comparative advantage since 1985	1999 exports in $US000s	Sectors that have gained a comparative advantage since 1985	1999 exports in $US000s
BOVINE CATTLE	3,279	HORSE MEAT FRSH,CHLD,FRN	1,383
BARLEY UNMILLED	12	FISH SALTED,DRIED,SMOKED	6,579
MALT INCLUDING FLOUR	1,868	EDIBLE VEG NES FRSH,DRY	3,033
FRUIT NUTS NES PRESERVED	8,417	FOOD PREPARATIONS NES	104,455
SUGAR PREPS NON-CHOCLATE	5,978	WINE OF FRESH GRAPES ETC	77,334
FOOD WASTE AND FEED NES	17,102	GOAT AND KID SKINS	218
MARGARINE,EDIBLE FAT NES	2,309	FUEL WOOD AND WASTE	896
BEER,ALE,STOUT,PORTER	8,259	WASTE PAPER	9,119
FUR SKINS UNDRESSED	81	FINE HAIR UNCOMBED	698
COARSE HAIR UNCOMBED	0	WASTE OF WOOL AND HAIR	935
WOOL SHODDY	5	ANIMAL,VEG FERTLZR,CRUDE	335
IRON ORE,ETC,EXCL PYRTES	16,226	SALT	3,158
PEAT AND BRIQUETTES	365	SLAG,SCALINGS,DROSS,ETC	3,228
PERFUME,COSMETICS,ETC	28,840	VEG USED IN PHARMACY ETC	2,310
BOXES,CASES,CRATES	2,028	COAL,EXCL BRIQUETTES	38,593
BUILDERS WOODWRK,PREFABS	18,791	OILS OF FISH,WHALES ETC	2,063
WOOD MFRS,DOMESTIC ETC	1,273	HYDROGENATED OIL,FAT	33,032
PAPER ETC IN BULK NES	13,524	INORG CHEM PRODUCTS NES	3,742
PAPER ETC CONTAINERS	10,745	COAL,PETR DISTILATES NES	36,391
CEMENT	5,701	WASHING PREPARATIONS ETC	37,565
DRAWN,BLOWN GLASS UNWRKD	6	PREPARED EXPLOSIVES	989
BOTTLES ETC OF GLASS	1,758	FUSES,PRIMERS,DETONATORS	797
STL,COPPER NAILS ETC	620	PESTICIDES,DISINFECTANTS	61,649
BASE METAL SAFES ETC	162	NEWSPRINT PAPER	86,960
OTH BASE MTL MANUFACTURS	30,406	OTHER PAPER ETC NES BULK	65,845
PARTICLE ACCELERATORS	0	PAPER ETC ARTICLES NES	29,774
INVALID CARRIAGES MOTRZD	215	TEXTILE FIBRE YARN NES	734
RUBBER CLTHG INCL GLOVES	628	LIME	4,776
PRINTED MATTER NES	20,650	SAFETY GLASS	12,879
ARTICLES OF PLASTIC NES	111,548	IRN,STL COIL FR REROLLNG	40,674
REAL JEWELRY,GOLD,SILVER	19,109	IRN,STL THIN COATED NES	51,103
BROOMS,PLAITED PROD,ETC	2,316	IRON,STL FORGINGS ROUGH	6,614
		COPPER,ALLOYS WORKED	51,733
		ALUMINIUM,ALLOYS WORKED	55,231
		LEAD,ALLOYS UNWROUGHT	5,134
		LEAD,ALLOYS WORKED	1,263
		MTL STORAGE,MF TANKS,ETC	5,643
		MTL TRANSPORT BOXES ETC	27,567
		IRON,STEEL FENCING WIRE	231
		SPRINGS AND LEAVES	6,519
		HARVESTING ETC MACHINES	21,644
		AGRICULTURE MACHINES NES	5,379
		NON-ELECT MACHINES NES	56,440
		LOCOS NOT STEAM,NOT ELEC	4,388
		WARSHIPS	20,245
		HEADGEAR	4,997
		CINEMA CAMERAS,PROJ,ETC	5,171
		MEDICAL INSTRUMENTS NES	54,715
		DEVELOPED CINEMA FILM	2,432
		BABY CARRIAGES ETC	1,844
		ZOO ANIMALS,PETS	1,685

Source: COMTRADE, NZIER

APPENDIX B

Table 7 List of sectors by area from Figure 4

Commodity code	Commodity	Area in 'Star performers' chart	NZ exports in 1999 $US000's	'World' exports in 1999 $US000's	NZ export growth by commodity, compound annual growth rate, %	'World' export growth by commodity	NZ's gain in market share $US000s
0223	MILK AND CREAM FRESH	1	74,370	4,443,745	17.5	12.9	31,528
0320	FISH ETC TINNED,PREPARED	1	48,231	8,794,339	8.9	8.7	1,250
0488	CEREAL ETC PREPS NES	1	32,732	3,985,208	21.7	17.0	14,035
0514	APPLES FRESH	1	273,574	2,531,700	12.3	7.9	116,552
0533	FRUIT,JAMS,JELLIES ETC	1	8,519	804,011	17.4	9.1	5,472
0541	POTATOES FRSH EXCL SWEET	1	9,737	1,806,003	10.1	8.9	1,407
0545	OTHER FRESH VEGETABLES	1	113,330	9,192,553	13.6	10.5	35,934
0551	VEG DRIED EXCL LEGUMES	1	5,208	983,139	11.6	8.3	1,782
0619	SUGARS AND SYRUPS NES	1	20,882	966,962	11.5	7.7	8,021
0990	FOOD PREPARATIONS NES	1	104,455	14,668,011	17.4	11.0	56,900
1121	WINE OF FRESH GRAPES ETC	1	77,334	14,658,966	31.6	9.7	71,312
2411	FUEL WOOD AND WASTE	1	896	336,184	43.0	12.0	867
2925	SEEDS,ETC FOR PLANTING	1	35,506	2,347,120	11.0	8.0	11,162
2927	CUT FLOWERS,FOLIAGE	1	31,308	4,553,549	12.3	9.7	8,837
4312	HYDROGENATED OIL,FAT	1	33,032	1,720,336	74.1	8.3	32,989
5542	WASHING PREPARATIONS ETC	1	37,565	9,398,344	25.4	11.1	30,679
5712	FUSES,PRIMERS,DETONATORS	1	797	306,285	43.7	9.0	780
5996	CHEMICLS FROM WOOD,RESIN	1	6,403	1,035,881	11.6	8.4	2,141
6312	PLYWOOD	1	66,685	6,801,951	17.0	8.8	42,581
6314	IMPROVED,RECONSTIT WOOD	1	23,159	4,943,924	13.2	12.1	2,918
6416	FIBREBOARD OF WOOD ETC	1	110,616	2,998,080	22.9	17.8	49,841
6419	OTHER PAPER ETC NES BULK	1	65,845	17,447,115	21.6	9.7	50,370
6429	PAPER ETC ARTICLES NES	1	29,774	12,272,921	14.8	10.0	13,483
6647	SAFETY GLASS	1	12,879	3,963,001	18.4	13.6	5,726
6727	IRN,STL COIL FR REROLLNG	1	40,674	11,988,367	103.1	7.6	40,668
6748	IRN,STL THIN COATED NES	1	51,103	14,888,180	48.0	9.0	50,398
6793	IRON,STL FORGINGS ROUGH	1	6,614	1,610,109	41.8	12.8	6,343
6822	COPPER,ALLOYS WORKED	1	51,733	13,813,499	15.2	8.2	30,267
6842	ALUMINIUM,ALLOYS WORKED	1	55,231	22,113,186	9.3	9.1	896
6921	MTL STORAGE,MF TANKS,ETC	1	5,643	1,417,995	18.1	8.2	3,983
6922	MTL TRANSPORT BOXES ETC	1	27,567	4,280,208	22.5	9.3	21,988
6986	SPRINGS AND LEAVES	1	6,519	2,618,274	25.4	12.9	5,021
7129	AGRICULTURE MACHINES NES	1	5,379	1,829,784	9.8	9.5	225
7196	NON-ELECT MACHINES NES	1	56,440	21,175,337	20.0	9.4	40,951
8617	MEDICAL INSTRUMENTS NES	1	54,715	22,385,021	20.7	14.7	27,638
8941	BABY CARRIAGES ETC	1	1,844	482,189	25.8	14.7	1,341
9410	ZOO ANIMALS,PETS	1	1,685	343,642	17.0	9.6	1,010
0311	FISH FRESH,CHILLED,FROZN	2	461,991	19,162,879	8.3	9.6	- 86,869
0313	SHELL FISH FRESH,FROZEN	2	173,533	13,499,148	4.0	8.6	- 141,801
0484	BREAD,BISCUIT,CAKE,ETC	2	21,530	8,073,440	6.2	12.1	- 24,243
0519	FRESH FRUIT NES	2	292,861	7,161,290	5.9	10.2	- 221,838
0536	FRUIT TEMPORARILY PRESVD	2	6,725	1,350,118	-1.9	10.7	- 29,550
0546	VEGETABLES SIMPLY PRESVD	2	51,557	6,482,830	6.7	16.7	- 128,027
0616	NATURAL HONEY	2	5,392	424,709	4.0	8.1	- 3,822
0730	CHOCOLATE AND PRODUCTS	2	36,337	6,984,728	6.0	9.9	- 23,650
1122	CIDER ETC	2	1,209	285,440	5.1	15.2	- 3,141
2711	ANIMAL,VEG FERTLZR,CRUDE	2	335	124,761	11.9	13.8	- 88
2919	ANIMAL MATERIALS NES	2	104,288	2,718,422	5.4	8.4	- 49,744
5416	GLYCOSIDES,GLANDS,SERA	2	27,349	10,061,511	6.9	17.0	- 70,079
5541	SOAPS	2	13,658	2,514,128	9.6	13.6	- 8,892
5995	STARCH,INULIN,GLUTEN,ETC	2	452,392	8,014,407	8.6	11.4	- 193,375
6114	LEATHR BOVINE NES,EQUINE	2	89,743	8,256,761	5.7	9.5	- 58,269
6122	HARNESS-MAKERS GOODS	2	1,101	382,482	5.7	13.1	- 1,741
6330	CORK MANUFACTURES	2	2,956	1,193,014	0.5	11.4	- 9,503
6413	KRAFT PAPER,PAPERBOARD	2	42,222	6,964,630	3.9	7.6	- 25,877
6422	CORRESPONDENCE STATIONRY	2	3,662	698,836	6.7	11.6	- 3,124
6423	EXERCISE BOOKS ETC	2	6,077	1,976,913	4.2	10.1	- 7,115
6562	MADE-UP CANVAS GOODS	2	3,460	1,054,076	-0.9	8.6	- 8,984
6566	BLANKETS,COVERLETS ETC	2	4,222	956,467	-3.6	10.1	- 22,610
6576	CARPETS ETC UNKNOTTED	2	48,861	6,349,796	-0.5	7.4	- 94,157
6912	STRUCTURES,PARTS ALUMNM	2	15,211	3,224,415	7.2	9.0	- 3,843
6971	DOMESTC STOVES,OVENS,ETC	2	8,144	2,629,250	-6.9	9.4	- 70,074
7250	DOMESTIC ELECTRIC EQUIP	2	85,923	30,557,866	7.5	9.6	- 26,887
8415	HEADGEAR	2	4,997	1,996,510	11.3	12.2	- 616
8924	PICTURE POSTCARDS ETC	2	2,772	1,003,711	-0.6	9.2	- 7,561
0111	BOVINE MEAT FRESH,FROZEN	3	631,579	14,110,259	2.3	5.9	- 390,705
0112	MUTTON ETC FRSH,CHLD,FRN	3	819,529	2,067,639	2.5	4.7	- 272,116
0116	EDIBLE OFFAL FRESH,CH,FR	3	47,040	1,555,263	0.4	6.2	- 55,281
0129	MEAT NES DRIED,SLTD,SMKD	3	181	50,278	-7.0	-5.5	- 47

0250	EGGS	3	3,351	1,356,987	-1.4	4.5	- 4,261
0470	MEAL AND FLOUR NON-WHEAT	3	2,550	432,311	-11.1	4.0	- 20,542
0542	LEGUMINOUS VEGTBLES DRY	3	15,109	2,380,636	-1.3	5.0	- 20,763
0814	MEAT OR FISH MEAL FODDER	3	19,478	1,941,549	-0.3	4.6	- 18,356
2111	BOVINE,EQUINE HIDES	3	20,972	2,524,189	-1.5	1.0	- 9,085
2116	SHEEP SKIN COMMON W WOOL	3	2,625	191,142	-3.6	-2.8	- 323
2117	SHEEP SKIN WITHOUT WOOL	3	89,328	230,666	-3.7	-1.1	- 40,572
2512	MECHANICAL WOOD PULP	3	42,294	274,097	-1.6	-1.4	- 1,385
2621	WOOL GREASY,FLEECE-WSHED	3	109,654	1,278,674	-6.5	-3.8	- 52,863
2622	WOOL DEGREASED	3	271,975	795,951	-3.0	-1.8	- 50,861
4113	ANIMAL OIL ETC,EXCL LARD	3	42,251	1,102,328	-2.2	-0.3	- 13,067
4314	ANIMAL,VEGETABLE WAXES	3	280	97,311	0.2	7.2	- 439
6318	WOOD SIMPLY WORKED NES	3	22,424	1,668,034	-2.9	6.0	- 53,929
6512	YARN OF WOOL,ANIMAL HAIR	3	50,603	2,075,716	0.7	2.8	- 16,830
6841	ALUMINIUM,ALLOYS,UNWRGHT	3	406,410	18,250,644	3.7	7.3	- 249,533
7121	CULTIVATING MACHINERY	3	6,839	1,924,578	4.6	5.2	- 634
7123	DAIRY-FARM EQUIPMENT	3	11,173	775,116	4.3	6.9	- 4,756
8420	FUR ETC CLOTHES,PROD	3	10,473	948,569	-1.1	-1.0	- 63
0015	HORSES, ASSES, MULES	4	70,714	1,311,914	4.8	3.4	11,951
0115	HORSE MEAT FRSH,CHLD,FRN	4	1,383	339,053	34.0	4.3	1,341
0118	MEAT NES FRESH,CHLD,FRZN	4	78,594	664,620	15.7	6.6	53,722
0133	MEAT EXTRACTS AND JUICES	4	1,787	99,028	10.9	4.3	1,038
0138	MEAT PREPD,PRESVD NES	4	25,256	4,154,974	8.6	6.6	5,843
0221	MILK CREAM EVAPD,CONDNSD	4	25,571	2,003,005	12.9	5.6	15,517
0222	MILK AND CREAM DRY	4	868,958	5,817,753	8.6	6.5	214,687
0230	BUTTER	4	514,457	2,968,934	3.2	2.5	47,076
0240	CHEESE AND CURD	4	509,752	10,385,868	10.1	7.4	153,373
0312	FISH SALTED,DRIED,SMOKED	4	6,579	2,451,947	12.9	7.3	3,333
0548	EDIBLE VEG NES FRSH,DRY	4	3,033	967,155	13.7	0.4	2,500
2112	CALF AND KIP SKINS	4	15,127	342,990	5.1	1.3	6,174
2114	GOAT AND KID SKINS	4	218	15,901	1.7	-9.6	176
2119	HIDES AND SKINS NES	4	3,571	182,713	14.0	3.8	2,604
2422	SAW-,VENEER-LOGS CONIFER	4	288,880	3,708,786	20.5	6.4	238,085
2432	LUMBER SHAPED CONIFER	4	377,144	17,361,997	14.2	7.2	220,878
2511	WASTE PAPER	4	9,119	1,833,880	19.0	6.5	7,173
2517	SULPHATE WOOD PULP	4	157,130	11,806,519	8.7	5.6	52,279
2623	FINE HAIR UNCOMBED	4	698	136,464	1.6	-2.5	308
2627	WOOL OR HAIR COMBED	4	6,328	509,969	10.3	6.5	2,413
2629	WASTE OF WOOL AND HAIR	4	935	92,474	41.9	-2.3	930
2763	SALT	4	3,158	875,842	17.1	5.8	2,395
2766	SLAG,SCALINGS,DROSS,ETC	4	3,228	261,377	32.6	1.8	3,149
2911	BONES,IVORY,HORNS,ETC	4	45,567	298,644	18.2	5.6	36,246
2924	VEG USED IN PHARMACY ETC	4	2,310	903,689	73.9	4.6	2,308
3214	COAL,EXCL BRIQUETTES	4	38,593	15,725,573	4.4	1.8	11,473
4111	OILS OF FISH,WHALES ETC	4	2,063	305,503	6.1	0.4	1,100
5122	ALCOHOLS,PHENOLS,ETC	4	97,518	11,316,529	10.1	7.2	30,349
5149	INORG CHEM PRODUCTS NES	4	3,742	1,298,597	36.3	5.0	3,645
5214	COAL,PETR DISTILATES NES	4	36,391	3,420,984	54.8	5.1	36,231
5711	PREPARED EXPLOSIVES	4	989	326,807	7.9	0.6	622
5992	PESTICIDES,DISINFECTANTS	4	61,649	11,039,526	24.5	6.5	54,701
6119	LEATHER NES	4	40,538	2,279,295	5.4	3.8	7,911
6130	FUR SKINS TANNED,DRESSED	4	21,247	798,133	10.0	-1.5	16,761
6411	NEWSPRINT PAPER	4	86,960	8,842,600	12.0	3.1	59,872
6519	TEXTILE FIBRE YARN NES	4	734	249,071	30.3	2.9	707
6556	CORDAGE AND MANUFACTURES	4	5,848	1,286,397	8.1	6.2	1,274
6611	LIME	4	4,776	199,783	37.4	5.0	4,665
6851	LEAD,ALLOYS UNWROUGHT	4	5,134	1,326,044	57.4	5.3	5,115
6852	LEAD,ALLOYS WORKED	4	1,263	155,688	19.3	5.9	1,026
6932	IRON,STEEL FENCING WIRE	4	231	83,843	10.4	0.9	165
7122	HARVESTING ETC MACHINES	4	21,644	6,346,228	7.1	6.4	1,896
8123	IRON,STL PLUMBNG FIXTRS	4	4,695	806,823	9.0	7.3	950
8630	DEVELOPED CINEMA FILM	4	2,432	427,272	41.4	5.7	2,391

Source: COMTRADE, NZIER

Economies of scale and imperfect competition: an application to the energy sector of the New Zealand economy

by

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Abstract: The impact of exogenous policy shocks may have significant impact on various sectors of the economy when certain features of industrial organizations are modeled. Features of industrial organizations such as economies of scale and imperfect competition may play a significant role in determining the extent of the effects of policy shocks. This paper attempts to model a CGE model focusing on the energy sector. The energy sector is assumed to enjoy economies of scale and compete in an imperfect competitive environment. Simulations are aimed to see if the result of simulations from such an environment affects simulation results when economies of scale and imperfect competition are absent using a CGE model.

Keywords: Economies of Scale, Imperfect Competition, New Zealand CGE

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1 INTRODUCTION

Does economies of scale and imperfect competitions in the energy sector have significantly different impact on the economy when there is a policy shock then when economies of scale and imperfect competition are absent? This question has been debated by academics since the influential paper by Harris (1984) where he first suggested that economies of scale and imperfect competition do have significant impact on the economy but in the context of trade liberalization. Although Harris argued that it does make a difference when one uses a general equilibrium model to assess the differences that economies of scale and imperfect competition make on the economy, others argued otherwise (Cory and Horridge, 1985; Horridge, 1987, Wigle, 1988)[1]. The latter studies argued that there is only about 2% to 5% increase in GNP from trade liberalization. Harris argued, however, that the benefits are higher, in the order of 8% to 12%, when economies of scale and imperfect competition are modeled in a general equilibrium framework.

The common assumption for modelling the effect of climate change and energy related policies on the economy are that there is constant return to scale as well as perfect competition in the economy. In reality, however, economies of scale seem to be the rule rather than the exception. Studies by Pratten (1971), and Buchanan and Yoon (1994) argued that economies of scale should be incorporated to energy and climate policy related models. In the energy sector, for example, many electricity-generating stations benefit from economies of scale. They may make use of resources that can be pooled together such as voltage transformers, equipment maintenance and the network of grid connection. Despite the suggestions by the above studies, modelling economies of scale and imperfect competition has been neglected by the literature. To date, many if not most of the global models assume constant returns to scale and perfect competition (eg. DICE and RICE, G-Cubed, Global 2100, GREEN, GTEM and WorldScan).

This paper will focus on the energy sector, in particular, to see if the impacts of a shock, to the energy sector, are significantly different when economies of scale and imperfect competition are modeled in a computable general equilibrium model. The aim is, not only to compare the impact of the energy sector on the economy, in the presence of economies of scale, but also to deduce whether it is likely for other uncompetitive forms of energy generation, such as energy generated by renewable technologies, to be economically competitive if there are economies of scale and imperfect competition in the new technology energy industries. We realize that the speed and direction of technological change will be critical for the success of green house gas emission mitigation policies around the world.

The paper is divided into the following five sections. The second section will outline a standard CGE model, which is extended to take into account economies of scale and imperfect competition in the third section. The fourth section presents the simulation results. The last section summarizes and concludes the study.

[1] See other studies mentioned in the Abayasirisilva and Horridge (1996).

2 STANDARD CGE MODEL

This paper, like most CGE models, uses the standard neo-classical model, where in the short-run there is restriction of access to the market but in the long run organizations are modeled as free agents who can enter the market or exit from the market as they wish. The main agents in the market include domestic producers, which is divided into *x* industries; investors which is also equals y industries and a single household, who received income and either spend or save the income. Imports are bought from a representative foreign agent, who purchases the imports. A minor agent in the model is the government, which is modeled but does not have a significant role in the economy like the other agents (like industries and households).

2.1 Structure of Production

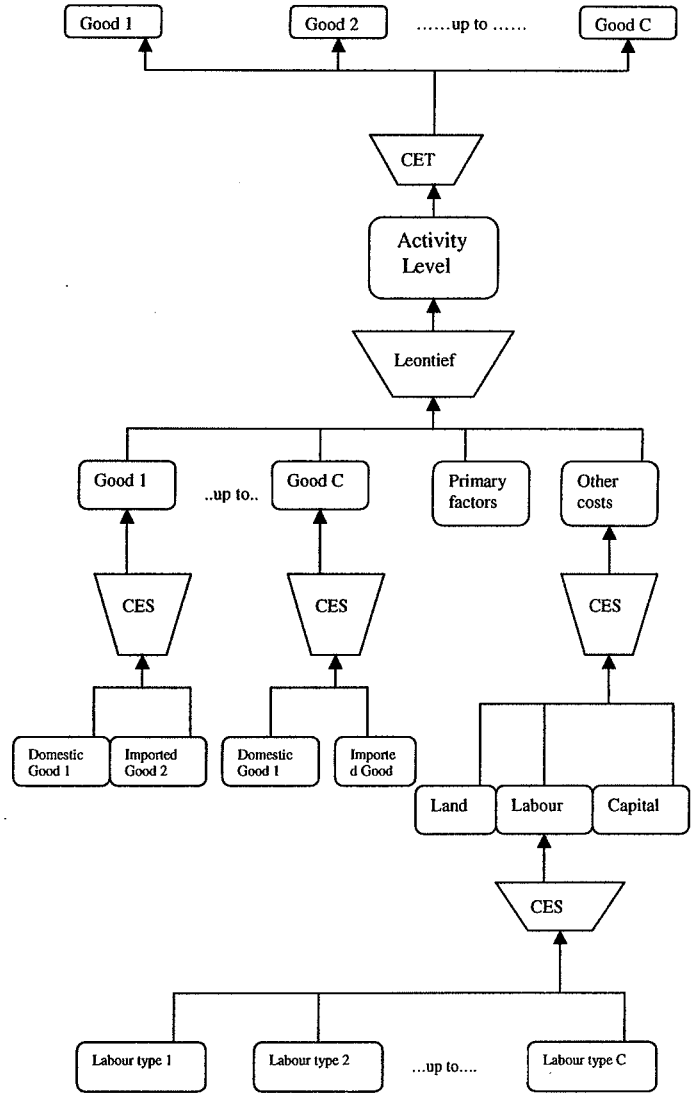
We follow the structure of production used by Abayasirisilva and Horridge (1996) and this structure of production is displayed in figure 1. At the top of the

Table 1: Commodities and Industries in the Model:

Commodities:	Industries:
1 agricultural products	1 agricultural products industries
2 animal products	2 animal products industries
3 forestry	3 Forestry
4 fishery	4 Fishery
5 coal	5 Coal
6 Oil	6 Oil
7 Gas	7 Gas
8 minerals	8 Minerals
9 meat and milk products	9 meat and milk products industries
10 other retail products	10 other retail products industries
11 wood and paper products	11 wood and paper products industries
12 petroleum and paper products	12 petroleum and paper products industries
13 chemical, rubber and plastic products	13 chemical, rubber and plastic industries
14 other minerals	14 other minerals
15 metals	15 metals
16 transport	16 transport
17 machinery and equipment	17 machinery and equipment
18 manufactures	18 manufactures
19 electricity, water and gas	19 electricity, water and gas
20 construction	20 trade, transport and construction
21 trade and transport	21 services
22 services	22 Houses
23 Houses	

figure are the goods produced by the economy, which in the model we used is equal to 23 commodities. These 23 commodities are produced by 22 industries (see table 1). Each of the 22 industries can produce either a single product or several

Figure 1: Structure of production.



commodities. The inputs would are from the labour sector, which is divided into either skilled or unskilled labours. In addition, there are also other production inputs of other commodities, which is either imported or bought domestically.

The main other inputs are from the sluggish factor land and capital. Because each industry can either produce multi-products or a single product with a number of different inputs, the task of modeling them is through a number of assumptions that allow for the separation of these products and inputs. This is seen in the nesting structure of the production sector in Figure 1.

The separability assumption allows flexibility in the production sector. The production function in some industries can be modeled as, H(inputs) = Y = H(outputs) rather than the traditional production function H(inputs, outputs) = 0 (Yasiri-Silva and Horridge, 1996). The separability assumption makes it easier to estimate the parameters, because it reduces the number of parameters to be estimated. In this model, the separable function of the output is derived from a constant elasticity of transformation aggregation function. The input separable function is divided into a number of nests. At the top of the nests for the input function, there is a composite commodity, which is a combination of the primary factor and 'other' costs. The composite commodity are combined by using a Leontief production function. This implies that all inputs are demanded in proportion to Y, an index about the activity in that industry. Like many other CGE models, the Armington (1969) assumption is used. This means that the composite commodity produced is a constant elasticity of substitution function of either a domestic good or its imported equivalent.

The composite input of primary factor is a constant elasticity of substitution combination of land, capital and composite labour. The composite labour is a constant elasticity of substitution of skilled and unskilled labour. This combination of composite primary input is the same across the number of *x* industries. However, this does not imply the same composite input and labour combination for every product produced because the input combination and the behavioural parameters are not the same across the 22 numbers of industries.

The household sector in the model is assumed to have a Stone-Geary utility function, which is used to aggregate the composite commodity demanded by the household sector. All other nests are the same as that for the primary-factor input nesting function (Yasin-Silva and Horridge, 1996). The other final demand sector is the government, which is assumed to have no substitution behaviour as in the household sector.

3 EXTENSION TO STANDARD CGE MODEL: ECONOMIES OF SCALE AND IMPERFECT COMPETITION

To model economies of scale we follow the CGE model by Abayasiri-Silva and Horridge (1996) because of the availability of their model. However, further discussions on incorporating scale economies in a CGE framework can be found in Devarajan and Rodrik (1988); Francois et.a. (1997); Harris (1984); Krugman (1980) and Melo and Tarr (1992). In the Abayasin-Silva and Horridge (1996) CGE model, they added two additions to the standard neo-classical model. They are new

technology and new pricing behaviour. The simulations were done using the standard neo-classical model with the addition of a new technology component and a new pricing component. Economies of scale are either modeled at the firm level or at the industry level. For the pricing part, Abayasiri-Silva and Horridge model it as being specified in the firm level and not at the industry level. The firms are modeled so enable the number of firms, in the short run, to be fixed, while in the long run, firms are determined by the number of firms entering or exiting the market. That is, in the long run, the firms are modeled so that they are free to enter or exit the market depending on whether they can maximize their profits by either entering or exiting the market (for further discussions on modeling market entry/exit see Brown (1992); Lopez et.al. (1996); Markusen et.al. (1996); Melo and Tarr (1992))

Each of the firms is modeled to produce a single or multi-products, which is assumed to be imperfect substitute of products produced in other domestics firms or produced by other foreign firms. The firms are assumed to be a price taker in the primary factor market while it is a price maker in the commodity final demand market. To make things simpler, increasing returns to scale are restricted to the single product industries. This makes the industry production function easier to model. The input functions are homogenous of degree 1, implying that production costs and the proportion of input used are flexible with respect to price but are inflexible with respect to the level of output produced.

At the firm level the production function is formulated as follows: L(inputs) = Z' = H(inputs) – F, where F is the fixed costs of production. The fixed costs are modeled so that they are directly related to the number of firms in the industry.

The firm's unit costs are given by the formula:

Unit Cost = $(F + Z_f) * M / Z_f$

The formulation of the unit costs ensures that as output increases the unit costs decreases to a minimum costs level, which is equal to the marginal cost. This minimum cost level is assumed to be the marginal cost of that product. The variable costs, on the other hand, are modeled so that they are proportional to the firm's output. This formulation of the unit costs ensures that marginal costs are independent of a firm's output.

3.1 Product differentiation

In an environment of imperfect competition, it is likely that there are a lot of product differentiation when products are close substitutes. In the CGE model used by Yasin-Silva and Horridge (1996), they simply add an extra layer of CES to show that consumers, in addition to consumers having a choice between imported and domestic produced products, can also choose amongst a variety of domestically produced close substitute products. They can also have the same choice for imported goods. We follow the Yasin-Silva and Horridge model but further discussion of product differentiation in a CGE settings are in Francois and Roland-Holst (1997) and Harrison et. al. (1993).

3.2 Two Pricing Rules and Imperfect Competition

There are two pricing rules that our CGE model follows. The first is the Lerner pricing rule and the second is the Harris pricing rule. Both these pricing rules are monopolistic pricing. In the Lerner pricing rule, the price set for an energy product depends on the elasticity of demand for that energy product. In particular, the price is set so that if the elasticity of demand is high, price will be lower. Conversely, the lower the absolute value of elasticity the higher the price. The Lerner price index is given by the formula $L = (P-MC)/P = 1/\varepsilon$ where P is the price, MC is the marginal cost of a given product, L is the Lerner index and ε is the elasticity of demand for that product. If P = MC then L = 0 implying perfect competition. But if P> MC, the L > 0 implying monopolistic pricing. The mark-up factor is equal to $P = [1/(1-L)]MC$.

In the Harris pricing rule, the price of the energy commodity is a mixture of the monopolistic pricing rule and the price of the imported energy product substitute. The price is set so that the price is a mean of the sum of the monopolistic pricing rule and the Harris pricing rule. This pricing rule gives a weight to each of the two prices and the average of these pricing rule is based on the size of the weight[2]. Although there are other price setting rules discussed in the CGE literature (see Brown (1992); Lopez et.al., 1996; Melo and Tarr (1992); Roberts and Tybour (1996), the two pricing setting rules we use is enough to model imperfect competition behaviour in the market.

4 SIMULATION RESULTS

To assess the impact of shocks to the energy sector, we simulate a shock to that would result in a reduction of output of chosen energy commodities. The shock is to increase the import price of energy commodities. One reason for doing this shock is also to assess whether the economic effect of trade liberalization in the energy sector is the same as having no trade liberalization in the energy sector. The shock to the energy sector is summarized in table 2.

The simulations we run were divided into short-run and long-run simulations. In the short-run there is a fixed number of industries. In the long-run, on the other hand, the number of industries are not fixed. Firms can enter the market or exit depending on the profitability of the market. This ensures that there is zero pure profits, consistent with neoclassical theory of short and long run behaviours of firms in the market. Furthermore, in each of these two categories we simulate both constant return to scale and increasing returns to scale. Increasing returns to scale were divided into either economies of scale from internal economies in an industry and economies of scale caused by more efficiency in the whole industry. The former is commonly known as internal economies of scale while the latter is known as external economies of scale.

In addition to the above simulations, we also added extra changes by changing the prices that industries faces. The change in prices are either a change in what has been described earlier as Harris pricing or prices are set according to the Lerner pricing rules. These two pricing rules ensures that the competition in the market are imperfect, hence enabling us to study the outcomes of policy shocks in an industrial environment characterized by economies of scale and imperfect competition.

The reference case is the simulation where all industries are having perfect competition with constant economies of scale. The effects in the economy of the reference case simulations are compared with the impact of both external and internal economies of scale in the energy sector as well as monopolistic pricing by industries in the energy sector.

Table 2: Percentage changes in the energy commodities:

Commodity No.	Commodity	% changes
5	Coal	-1.71
6	Oil	-0.80
7	Gas	-3.65
8	Minerals	-5.86
12	Petroleum products	-8.75
13	Chemical & rubber	-7.65
14	Other minerals	-5.65
15	Metal products	-5.62
19	Electricity & gas	-6.63

4.1 Short-run Simulation

In the short-run simulation, the various price indexes (as represented by the macro variables such as GDP price index, investment price index, export price index and import price index) fall as a result of the decrease in the emission intensive products' prices. Consequently output produced increase, which results in a boost to aggregate output produced in the economy. Real GDP increased by between 0.42 to 0.94. However, some industries output fall as a result of the shock. This was especially true for import intensive industries such as minerals and petroleum products. Export intensive industries face a more elastic demand from overseas and also benefited from the reduction in its production cost caused by the shock to the emission intensive products. Hence, for most of them, their production level increased.

The details for the metal sector, as in the last four rows of table 3, shows that the marginal emission cost fall for all the simulations. The fall in marginal cost was at an average of about 2.1 percent. Lerner price also fall by about 2.1 percent for all simulations. Regardless of whether it was constant or increasing returns to scale, the number of industries in the metal sector also seems to decline by about 0.5 percent across the simulations. Employment in the metal sector, however, seem to increase between 3.52 percent in the short-run constant return to scale simulations to about 9.1 percent in the short-run increasing return to scale scenarios.

Table 3: Short-run Simulations:

[2] For a more technical discussion of the Lerner and Harris pricing rules see Yasiri-Silva and Horridge (1996).

Scale	Constant Return to Scale	Constant Return to Scale	Increasing Internal Return to Scale	Increasing Internal Return to Scale	Increasing External Return to Scale
Pricing	Harris Pricing	Marginal Pricing	Lerner Pricing	Harris Pricing	Marginal Pricing
Macro Variables:					
Employment	0.908893	1.056747	1.068891	0.797521	1.403643
Duty-paid Import P.I.	-1.38779	-1.38779	-1.38779	-1.38779	-1.38779
GDP P.I.	-0.93979	-1.49047	-1.6206	-0.9567	-2.0093
Investment P.I.	-0.58023	-1.18159	-1.23648	-0.58149	-1.60352
Consumer P.I.	-0.85525	-1.27207	-1.37751	-0.58149	-1.69065
Export P.I.	-0.74851	-0.91961	-1.04495	-0.58149	-1.26924
Real GDP	0.42733	0.572795	0.692298	0.4716	0.943756
Import Volumes	0.270191	0.099771	0.050145	0.196105	-0.43685
Capital Stock	0	0	0	0	0
Real Investment	0	0	0	0	0
Commodities Outputs:					
Agricultural products	0.74593	0.938682	0.996172	0.743389	1.182747
animal products	0.924636	1.157245	1.21529	0.914776	1.445977
Forestry	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*
Fishery	-0.10443	0.019474	-0.00995	-0.14025	-0.0116
Coal	1.346377	0.551019	0.982557	1.517636	1.211804
Oil	2.696998	0.16591	1.30973	3.391981	1.207103
Gas	-0.22095	-0.05964	-0.1465	-0.26872	-0.14573
minerals	-4.23406	-0.06061	-2.02402	-5.39337	-1.43668
meat and milk	1.181766	1.241109	1.599344	1.236004	1.896447
Other retail products	0.805316	1.258017	1.398997	0.822445	1.810081
Wood and paper	1.05004	1.105297	1.196753	0.990435	1.513091
petroleum products	0.405683	-0.4397	-0.34176	0.294198	-0.18981
chemical, rubber	0.98615	-0.12746	0.073304	0.918696	0.373282
Other minerals	1.955058	-1.00454	-0.19782	1.976783	-1.416
Metals	0.643407	0.188714	0.156918	0.590136	1.100691
transport	2.768828	4.482662	3.994679	2.693385	7.194081
machinery and equipment	1.266642	2.179244	2.303591	1.282828	3.230108
manufactures	1.841881	1.861264	2.451492	1.928572	2.726734
electricity, water and gas	1.939087	1.157617	1.085532	1.871928	1.743406
construction	0.136705	0.275138	0.296987	0.11686	0.376882
Trade	0.434297	0.763247	0.830104	0.415877	1.080791
services	0.219081	0.368807	0.385429	0.194398	0.500959
Houses	-0.00012	-2.6E-05	-2.7E-05	-0.00013	-3.1E-05
Details for metal sector:					
Marginal cost	-2.22869	-2.0899	-2.18191	-2.25044	-2.33136
Lerner Price	-2.22791	-2.08844	-2.17942	-2.24926	-2.32988
No. of firms	-0.64341	-0.18871	-0.15692	-0.59014	-1.10069
Employment	3.525924	6.266743	4.961431	3.120772	9.546997

Table 4: Long-run simulations results

Scale	Constant Return to Scale	Increasing Internal Return to Scale	Increasing Internal Return to Scale	Increasing External Return to Scale
Pricing	Marginal Pricing	Lerner Pricing	Harris Pricing	Marginal Pricing
Macro Variables:				
Duty-paid Import P.I.	-1.38779	-1.38779	-1.38779	-1.38779
GDP P.I.	-0.55817	-0.2392	-2.0766	-0.6072
Investment P.I.	-0.30053	-0.27706	1.373642	-0.33147
Consumer P.I.	-0.4177	-0.23096	0.135799	-0.45955
Export P.I.	-0.67013	-0.0753	-0.98353	-0.70422
Real GDP	0.219779	-0.04519	0.542404	0.24653
Import Volumes	0.975589	0.608936	0.143511	0.959584
Capital Stock	0.216203	0.265362	1.866058	0.227348
Real Investment	0.216203	0.265362	0.866057	0.227348
Real Consumption	0	0	0	0
Commodities Outputs:				
Agricultural products	0.649282	0.394571	-1.169	0.667167
Animal products	0.899671	0.439553	-7.21397	0.909333
forestry	0.000000*	0.000000*	0.000000*	0.000000*
Fishery	-0.34697	-1.22701	-69.329	-0.42491
Coal	0.919552	0.573171	1.93368	1.027724
Oil	-1.21588	-1.45124	-188.48	-1.30535
Gas	-0.289	0.033307	3.654307	-0.32395
minerals	5.904673	-1.5289	-211.406	6.487323
meat and milk	0.558635	0.617554	5.058464	0.611811
other retail products	0.892269	0.035375	2.99067	0.97798
wood and paper	0.524637	0.913063	1.20617	0.583911
petroleum and coal	-2.93704	0.519245	-14.1429	-3.11591
chemical, rubber	-2.0323	-2.87037	1.24299	-2.15985
other minerals	-1.03577	-9.29662	2.1528	-1.16401
Metals	-1.18034	0.192043	1.83224	-1.20022
transport	1.630525	1.340885	3.39846	1.906714
machinery and equipment	1.010278	0.780738	13.4196	1.176844
manufactures	0.712994	-0.43964	0.86811	0.782263
electricity, water and gas	0.234129	0.893312	2.58691	0.237384
construction	0.111871	0.052258	0.994181	0.121204
Trade	0.370417	-0.05037	0.369729	0.405232
services	0.104613	0.045411	5.815456	0.109087
Houses	-0.23613	0.09028	-14.8971	-0.24874
Details for metal sector:				
Marginal cost	-1.26927	-0.59396	-1.67658	-1.27289
Lerner Price	-1.28049	-0.59841	-1.89045	-1.28417
No. of firms	-1.18034	0.147607	-0.04572	-1.20022
Employment	0.851261	0.222507	0.64622	0.927805

The last three columns of Table 3 present results for both internal and external increasing returns to scale. It seems from the changes in these columns that there is not much difference between the constant return to scale simulation results and the increasing return to scale simulation results. This may be because of the use of the marginal costs rather than average costs in the pricing rules described in the second

row of Table 3. The small differences that is evident in the simulations can be attributed to the use of resources where profitable sectors use more resources and non-profitable sectors use less resources than under the constant return to scale scenarios.

4.2 Long-run Simulation

Table 4 presents the results for the long-run simulations. The price indexes also fall as in the short-run simulations but the fall in the long-run seems to be smaller than the percentage fall in the short-run simulations. This result seem to extend to all the price indexes. The increase in real GDP and import volume seem to be not very different from the short-run results. However, in the long-run the increase comes from increase capital use as labour is fixed in the long-run.

In the output sectors, the same sectors that were losers in the short-run simulations were also losers in the long-run simulations regardless of whether it was constant return to scale or increasing return to scale. For example, in the petroleum products industries the average fall in output was about 0.1 percent. In the long-run, the fall in output seem to be at a higher percentage than in the short-run simulations. The fall was between 2 – 14 percent in the long-run simulations. This may be because of increased absorbtion in the long-run because the ratio of investment to capital was fixed in the short-run (Abayasiri-Silva and Horridge, 1996).

In the long-run the firms were free to enter or exit from the market. Resultedly, the Lerner price change is less in the long-run than in the short-run (Abayasiri-Silva and Horridge, 1996). Another possible change because of the free entry or exit of firms is that mark-up may be very small so that the price faced by the firm is almost equal the marginal cost. For that reason, it is possible that firms now faces a scenario where return to scale is almost constant.

5 SUMMARY AND CONCLUSION

In this paper, we model the economy to reflect the reality that there are economies of scale in some industries and that imperfect competition also exists in the market. We have used a computable general equilibrium model to reflect the fact that there are economies of scale and imperfect competition in the market place. We model both short-run and long-run scenarios. In both the short and the long-run scenarios, we distinguish between constant return to scale and increasing return to scale. We distinguish the sources of increasing returns to scale – that is, it can be either internal economies of scale or external economies of scale. We also distinguish between different types of prices that may exist in the market place. We use three different price rules. They are Harris price rules, Lerner price rules and marginal cost pricing.

Our results for the reference case show that while import intensive sectors shrink, export intensive sectors seem to expand because of the increase in international competitiveness resulting from the induced shock to the economy. In the short-run, the change of resources to export intensive industries were

slower. In the long-run, however, it was easier for firms to shift resources to the most profitable industries.

From our results, one could say that the results from the constant return to scale were often not very different from the results obtained from the increasing returns to scale scenario. This was especially true for the Lerner pricing rules and internal economies of scale. This observation was also true in the Abayasiri-Silva and Horridge (1996) study. Overall, however, we found that the shock introduced to the energy intensive sectors seem to have results that were not significantly different between the short and long-run and between constant return to scale and increasing returns to scale. Further work in this area, therefore, is still to be done.

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THE COOPERATIVE VERSUS THE INVESTOR-OWNED FIRM IN AGRICULTURE: THE WESFARMERS CASE STUDY

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Abstract

The relative efficiency of cooperatives versus investor owned firms is a hot issue in New Zealand and around the world. Given commitments made to agriculture tariff reductions (Uruguay round of GATT) and the potential subsequent welfare gains, choosing a structure that maximises the value of the industry is of national interest. Hence the question: Do cooperatives create more value than investor owned firms? This paper reviews the economic theory of cooperatives and related corporate finance theory before focusing on a specific case. The Wesfarmers Ltd case study provides a unique opportunity to review the transformation of a cooperative into an investor owned firm and the resulting business and economic implications.

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INTRODUCTION

Ownership structures are unique, and therefore the optimal structure for one industry is unlikely to be optimal in other industries. Different structures also involve different tangible and intangible costs. Familiar to most, are the accounting based, processing, management and control costs, but less obvious are intangible costs such as the accessibility to financing and agency costs. Clearly by recognising that different industry structures are associated with different costs, then maximising the value of any industry will be dependent on the industry structure selection.

The future success of the New Zealand Dairy industry is of critical importance not only to dairy farmers but to the New Zealand economy. Moreover the World Trade Organisation (2002) has estimated the gains for New Zealand from commitments made to agricultural tariff reductions, at the Uruguay Round of GATT negotiations are equivalent to 1-3 percent of New Zealand's GDP. Finding the structure that maximises the value of the Dairy industry was a contentious issue when the 'dairy mega merger' was proposed. Subsequently, the New Zealand Government and the New Zealand Dairy industry have with the formation of Fonterra entrusted the future of the New Zealand Dairy industry to cooperative ownership.

Their decision to follow a cooperative ownership structure is consistent with international evidence that cooperatives appear to be the dominant form of agricultural reform. Mooney and Gray (2002) find that cooperatives are taking over investor owned firms (IOFs) at three times the rate that IOFs take over cooperatives. By way of contrast the Westralian Farmers Cooperative is an example of an agricultural cooperative that has taken on the challenge of restructuring into an IOF, and provides a real life opportunity for empirical analysis of post IOF performance.

The limitations of case study analysis

It is important with any analysis to have an understanding of the limitations of the analysis methodology before discussing the insights that the analysis provides. Mooney and Gray (2002), have the following to say about agricultural case studies:

> *The conversion case studies are scientifically sound, only if the cases studied represent all, or at least a representative sample, of the potential cases of conversion* (p.7).

Following Mooney and Gray, 'ideally' not just conversions should be considered but rather other cooperatives that have market values greater than book values that do not become IOFs.

Although, even this extended sample fails to consider IOF's that become or could derive an advantage from becoming a cooperative. Acknowledging the difficultly of forming a full sample and accepting the criticism of Mooney and Gray, to dismiss agricultural case studies simply on their statistical strength may be misleading. Instead when assessing the implications of conversion derived from agricultural case studies a degree of caution or scepticism is advisable especially where the industry characteristics vary.

THE STORY OF WESFARMERS LIMITED

Wesfarmers Rural business began as a stock and station business established by Western Australian producers in 1902. The primary focus was the provision of services and merchandise to farmers. In 1984 Westralian Farmers Co-operative Limited transformed in to an IOF[1] and listed on the Australian stock exchange. Historically Wesfarmers have followed a horizontal diversification strategy and at present Westfarmers controls 142 entities, of which over 95 percent are fully owned. In addition Wesfarmers have a shareholding in another 16 associated entities (Wesfarmers annual report, 2001). Their diversified interests include, Hardware, Gas, Coal, Fertilisers & chemicals, Rural services & insurance, Forest products, Road & rail transport, and Industrial & safety products distribution. For 2001 financial year Wesfarmers total group revenue was $4.39 billion (Australian dollars) and was generated from assets of $4.15 billion (Table 1).

Table 1 Segmentation Analysis 2001.

Source: Wesfarmers 2001 annual report (p.65).

	Operating revenue		Industry assets		Earnings before tax		Return on assets employed (before tax)
	A$000 (millions)	Percentage of total	A$000 (millions)	Percentage of total	A$000 (millions)	Percentage of total	
Rural services and insurance	1,272,054	29%	1,115,004	27%	56,990	12%	5%
Fertilisers and chemicals	438,058	10%	539,049	13%	52,624	11%	10%
Energy	978,132	22%	1,043,829	25%	190,126	40%	18%
Hardware and forest products	1,541,747	35%	840,174	20%	145,876	30%	17%
Other – investments and services	167,248	4%	614,164	15%	32,375	7%	5%
Total	4,397,239	100%	4,152,220	100%	477,991	100%	

[1] Under the arrangement Westralian Farmers Co-operative was sold to the subsidiary Wesfarmers Limited. Wesfarmers Limited issued 15.6 million shares that were issued free of charge to the then stockholders of the Co-operative.

WHY WESTRALIAN FARMERS COOPERATIVE EVOLVED INTO AN IOF

The Wesfarmers 1985 annual report states the reasons for their evolution into and investor owned company.

> *The purpose of the restructure was to enable shareholders of Westralian Farmers Co-operative Limited to benefit from the success and growth of the company over its seventy year history and to give the group improved access to equity finance markets. Under the co-operative corporate structure, shareholders had been unable to obtain capital growth on their share investments and the dividend payments were approaching the statutory maximum* (Wesfarmers Annual Report, 1985, p.3).

Becoming an IOF has allowed Wesfarmers to adopt a single corporate objective of 'providing a satisfactory return to shareholders'. The movement away from the multi-dimensional objectives of a cooperative to the single IOF objective is described by the current managing director of Wesfarmers as testimony to the vision and integrity of a group of rural Australians (Chaney, 1999).

- A group of Australians who put commercial priorities ahead of populist or agricultural ones.
- Who recognised the value of incorporating into a public and embracing all of the commercial disciplines that it entailed.

DIFFERENCES BETWEEN THE OBJECTIVE FUNCTIONS OF COOPERATIVES AND IOFS

Cooperative literature exhibits a significant amount of controversy around the relevant objective of the cooperative organisation. The conjecture centres fundamentally on the differences between IOF and cooperative firms. In the IOF firm[2], the objective is to maximise profit and subsequently the return to the owners is also maximised. This is not necessarily true of the cooperative because the owners are also the patrons, and their interest is in maximising returns on the cooperative final output (or cooperative activity) plus the maximisation of returns on the raw product that they supply to the cooperative.

ANALYSIS OF THE MOTIVES FOR RESTRUCTURING INTO A IOF

Becoming an IOF may not be motivated by any one reason and as reflected by the purpose of the 'Wesfarmers restructuring.' The fundamental cooperative principles including the limited return on capital[3] may in fact contain the seeds of the cooperatives own destruction. This point is made by Schrader (1989) who finds that the cooperative practices, as well as legislation based on cooperative principles can result in a chronic shortage of capital, and

[2] Non-profit private firms are excluded.
[3] The limited return on cooperative capital is often legislated.

lacks a mechanism to reflect the equity appreciation on the cooperative members' capital contributions.

Successful cooperatives have a larger divergence between the book value of the cooperative assets and the value of expected future returns. This is simply because the equity contributions are not market traded and therefore fail to account for future expectations. Therefore a cooperative dilemma develops, where a cooperative has net earnings in excess of the opportunity cost of capital resulting in the cooperative being worth more to investors as an IOF than it is too many cooperative patrons (Schrader, 1989).

Access to finance is critical especially for business managers who see growth[4] as being important to future success. The managers ability to access financing may be limited if cooperative membership is unwilling to accept greater leveraging or provide additional equity capital (Collins, 1991, cited in Mooney & Gray, 2002). Conceivably the financing restrictions can see the cooperative being forced to turndown positive net present value investment opportunities.

Corporate acquisitions from a shareholders perspective should add value to the acquiring firm. However, Dodd and Ruback (1977), and Kummer and Hoffmeister (1978) find that only target shareholders earn significantly positive abnormal returns while the acquiring firms earn little or no abnormal return. Similarly, Loughran and Vijh (1997) find that for target shareholders who choose to hold on to the acquirers stock after the acquisitions do not earn significantly positive abnormal returns although if they decide to sell the stock at acquisition positive abnormal returns exist.[5] Often this phenomenon is explained by over confidence[6] on the part of the acquirer, or simply by 'mean reversion' of returns over the three to five year horizon. In any case the issue is simply that transforming into an IOF may be advisable when the market value of the cooperative is high (Mooney & Gary, 2002) and shareholders therefore can benefit from becoming an acquisition target.

Wesfarmers restructuring, although not motivated by a single reason, does contain a common thread being 'Capital'. Investor-owned firms are likely to have greater access to financing, enabling increased growth and lower agency costs due to increased monitoring by the debt markets.[7] They also enjoy fewer restrictions on capital returns which encourage greater equity investment. Other motives for restructuring such as the cooperative's greater divergence between book value of assets and the value of expected returns, is in essence still a capital problem.

Table 2 Financial ratio analysis 1985 to 2001 (at year ended 30th June)
Source: Calculated from the balance sheet and profit and loss statements, Wesfarmers annal reports

	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992
Efficiency										
Accounts receivable turnover (days)	55.89	51.78	49.39	48.67	51.03	55	55.23	49.3	48.67	45.14
Inventory turnover	6.12	5.94	5.93	6.63	6.8	6.68	6.97	7.39	6.22	6
Total asset turnover	1.18	1.17	1.14	1.24	1.28	1.24	1.34	1.49	1.3	1.13
Accounts payable to sales	14.84%	16.69%	14.14%	14.22%	14.85%	14.08%	13.12%	13.43%	10.99%	12.29%
Profitability										
OPBAT as a percentage of sales	8.72%	8.84%	8.92%	9.46%	8.43%	6.26%	7.58%	7.82%	7.54%	8.44%
Net profit (before abnormals) as % or sales	5.93%	6.19%	6.39%	6.09%	5.39%	3.84%	5.32%	6.87%	5.01%	5.24%
Return on equity (before abnormals)	15.55%	16.87%	14.92%	14.25%	13.85%	10.47%	15.46%	21.09%	13.87%	11.85%
Solvency										
Liquid ratio (liquid assets/quick liabilities) excl. borrowings	0.83	0.71	0.62	0.66	0.6	0.72	0.76	1.03	0.76	0.77
Liquid ratio (liquid assets/quick liabilities) incl. borrowings	0.61	0.48	0.47	0.51	0.48	0.54	0.55	0.75	0.56	0.56
Current ratio (current assets/current liabilities)	1.12	0.91	0.97	0.95	0.93	0.96	1.01	1.16	1.1	1.08
Working capital $000m	165,765	-113,799	-24,279	-43,538	-60,453	-28,183	4,908	116,244	51,987	36,834
Financial structure										
Debt/equity	1.47	1.57	1.13	1.03	1.03	1.24	1.31	1.28	1.21	1.25
Equity to assets	0.4	0.39	0.47	0.49	0.49	0.45	0.43	0.44	0.45	0.44
Term liabil. To fixed assets	0.4	0.33	0.25	0.22	0.17	0.26	0.28	0.28	0.29	0.33
Financial leverage multiplier ratio (total assets/equity)	2.47	2.57	2.13	2.03	2.03	2.24	2.31	2.28	2.21	2.25
Times interest earned ratio	6.2	9.92	11.18	14.57	8.52	4.52	6.37	8.22	5.46	4.05
Market ratios										
Dividend per Share	0.87	0.74	0.68	0.66	0.58	0.37	0.49	0.41	0.29	0.26
Dividend payout ratio	0.97	0.93	0.99	0.99	0.99	0.9	0.83	0.52	0.65	0.73
Price to earnings	27.82	14.32	13.77	12.1	12.66	8.45	10.74	16.66	8.85	8.03
Net asset backing	5.74	4.74	4.61	4.66	4.22	3.9	3.8	3.75	3.2	2.98
Market/book value	4.72	2.81	2.95	2.57	2.97	1.94	2.35	2.29	1.8	1.98
Change in sales	26.35%	19.22%	2.88%	5.29%	6.82%	0.30%	6.46%	33.80%	35.18%	2.58%

[4] Agency costs involved with growth strategies are significant therefore growth may not be in the best interest of the shareholders but rather pursued from the interest of managers. In particular management power is typically a function of the resources they control. Therefore management has an incentive to grow the firm beyond its optimal size (Jesen, 1986).
[5] This is at least in part consistent with prior research on the basis that the target shareholder still holds a positive abnormal returns option that may be exercised.
[6] Expectations of synergies that don't come to fruition.
[7] This point is supported by the managing director of Wesfarmers (Chaney, 1999) in his reference to commercial disciplines of becoming a public company.

WESFARMERS FINANCIAL ANALYSIS

The Wesfarmers financial data was collated from their first annual report (1985) as a public company to the most recent (2001), to form a balance sheet and profit and loss statement for the post restructure period. Changes to yearly classifications were reviewed in line with the 'notes to the accounts' therefore allowing adjustments to be made to maintain consistency in classifications over the review period. The financials were then checked against the Financial Analyst Database to identify and correct discrepancies. Performance ratios were then calculated from the financial statements and are reported are report in table 2.

Ratio analysis is employed for the purpose of evaluating the Wesfarmers performance and financial position. The analysis reviews efficiency, profitability, solvency, financial structure, and markets perception of the consolidated entity. The performance is then reviewed by industry type to determine strong and weak performing industries within Wesfarmers investments. Identified earlier, the motives for becoming an IOF included accessing financing and allowing shareholders to obtain capital growth on their equity investment.[8] The efficiency of post restructuring financing is reviewed by analysing changes in various measures of 'growth rates'[9] along with the market capitalisation. In essence a change in growth rate could be indicative of the productivity of new capital investments.

Efficiency

The efficiency ratios are employed to evaluate how effectively the assets of Wesfarmers are being managed. The inventory turnover has been between six and seven times per year since the early 1990s and the efficiency of assets in generating sales as shown by the total asset turnover has generally declined since 1998. This would support diseconomies of scale in the assets employed; although it is conceivable that assets are being purchased that will generate revenue in the future. The accounts payable as a percentage of sales has increased from ten percent in 1986 to 15 percent in 2001, therefore Wesfarmers are receiving more favourable credit terms as the company has grown. The receivables collection period increased between pre and post 1992. This change coincides with Wesfarmers increasing their holding in Bunnings Limited to 45 percent[10] and may well reflect different credit terms although collection periods over 40 days are indicative of slow-turning receivables.

Profitability

The profitability ratios are calculated to determine the success of Wesfarmers in creating wealth for the shareholders. The operating profit (gross) before abnormals and tax (OPBAT) indicates Wesfarmers profitability, and has generally ranged between five and nine percent, although the return has increased from 1990. The return of equity measured as net profit divided by shareholders funds, over the seventeen years has averaged 14.5 percent. Only once since becoming an IOF has the return on equity fallen below nine percent. This provides support for Wesfarmers diversification strategy,[11] stabilising the returns on capital investment. Their ability to control their costs is reflected by the stable net profit to sales ratio of around five percent.

Solvency

Suppliers and lending institutions are concerned with the business solvency. The liquid ratio measures Wesfarmers ability to meet short-term liabilities and has for long periods fallen below the critical point of one,[12] where quick liabilities are equal to quick assets. Similar concerns are found from 1996 to 2000 with negative working capital. The ratio of current assets to current liabilities is also low (around one) although not at a critical level. From the solvency ratios creditors appear to be risking funds especially in the short-run as Wesfarmers' continue to operate on low levels of liquid assets.

Financial structure

This section reviews the gearing that Wesfarmers has undertaken. Financial gearing provides a tax shield but increases bankruptcy risk as debt financing carries the obligation to make interest repayments. While no such payment liability exists for equity financing. The calculated debt-equity ratio shows since restructuring, Wesfarmers have increased their gearing from approximately $1 to$1.50 for each dollar of equity. What is interesting is that gaining access to the equity markets was a stated motive for restructuring and since becoming an IOF Wesfarmers' equity has increased from $192,255 (000m) in 1985 to $1,617,808 (000m) in 2001. However, the largest proportion of the financing as indicated by the debt equity ratio has come from the debt markets. Therefore debt rather than equity appears to be the preferred financing method[13] and the potential agency costs of investment are likely to be lower in the restructured firm. In addition shareholders may also prefer debt financing as it provides a tax shield.

The times-interest-earned ratio is important to financial institutions as it indicates the ability of available earnings to cover the interest expense, and therefore the likelihood of obtaining additional debt financing. Generally a ratio of five and above is comfortable and with Wesfarmers' calculated ratio above six in most years further debt financing is an option.

Market ratios

The market ratios are important as they enable management to evaluate the market perception of Wesfarmers past performance and future prospects. Over the seventeen year period the earnings per share have consistently increased from under ten cents per share (1986) to 87 cents (2001). Significantly the net asset backing has also

[8] Refer to the section on the 'History of Wesfarmers' and Wesfarmers stated purpose of restructuring.
[9] In essence trying to establish if the productivity of new capital increases.
[10] Complete ownership of Bunnings limited was achieved in 1995.

[11] The value of diversification strategies in corporate finance is a topic of debate due to the potential agency costs (managers can hide poor performance) and it is often argued that the diversification is better left to the investor.
[12] The Wesfarmers current borrowing has remained relatively stable at approximately one quarter of current liabilities and therefore is unlikely to be included as a quick liability.
[13] Management may simply prefer to issue equity when they consider the share price to be overvalued by the market and issue debt when they consider the share price to be undervalued.

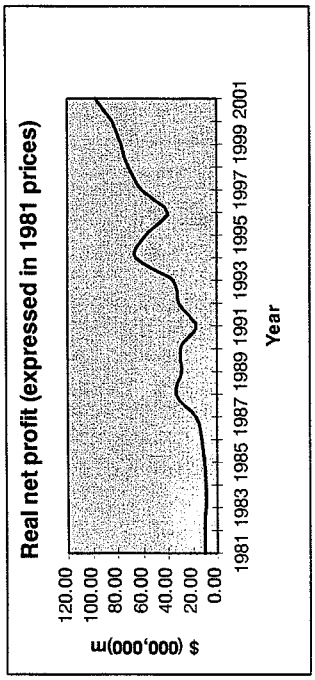
increased from under $2 per share (1987) to $4.72 (2001). The increasing market to book ratio and increasing price to earnings ratio is indicative that the market believes that Wesfarmers have future growth potential.

Segmentated analysis

Wesfarmers are following a diversification strategy and the segmented analyses in table 3 breaks down where assets are employed and the returns received within each industry. This allows industries that are creating and destroying shareholder wealth to be identified. The investment in energy has consistently provided returns between 15 and 23 percent and is presently the largest single revenue earner. Rural operations, insurance and investments involve substantial investments in assets with returns consistently in the four to five percent range. Although rural operations, insurance and investments provide value through diversification it is unlikely that the gains from diversification offset their poor returns.

Real variables

This section graphically presents the history of Wesfarmers net profit, operating profit, revenue, and dividends. The data for the pre IOF years (1981-85) was sourced from the Wesfarmers 1985 annual report which provided a comparison for the Wesfarmers (consolidated) as if the restructure had taken place on the 30th June 1980.



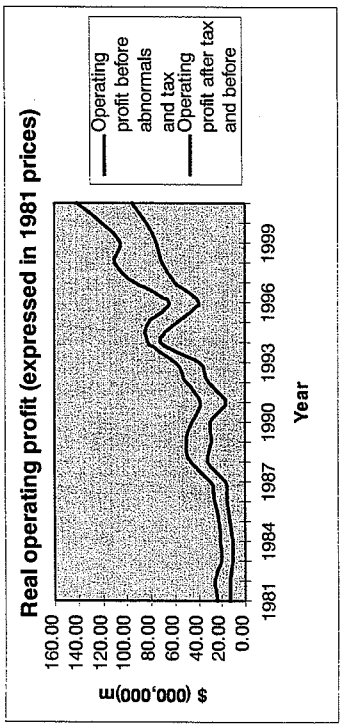
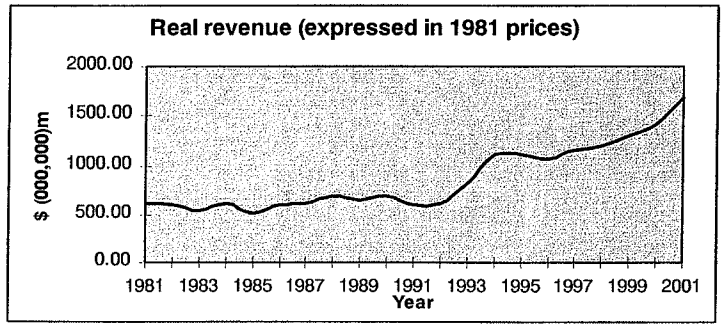
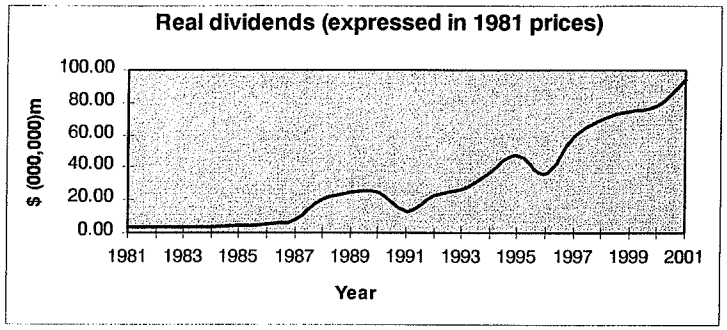


Table 3 Wesfarmer segmentated financial ratio analysis 1985 to 2001 (at year ended 30th June)
Source: Wesfarmers annal reports (1986-2001)

	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986
Consolidated turnover	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m	$000m
Rural operations, insurance and investments	1,272,054	847,652	755,511	739,441	677,680	655,961	697,963	586,700	342,488	290,830	540,080	711,380	693,945	645,919	604,221	463,403
Fertiliser and chemicals	438,058	403,146	419,504	467,592	531,294	415,400	365,756	325,019	195,648	189,857	182,275	234,631	213,667	210,434	162,975	150,741
Energy	978,132	588,756	471,736	455,133	453,923	419,649	408,631	328,283	331,602	296,448	255,404	183,664	61,300	49,443	44,540	31,449
Hardware/building and forest products	1,541,747	1,498,391	1,170,004	892,415	794,800	756,027	786,613	738,680	527,180	183,042						
Other	167,248	164,612	159,364	273,772	258,305	266,273	239,152	343,098	336,903	323,197	273,532	242,040	221,727	282,303	209,956	216,327
Total	**4,397,239**	**3,502,557**	**2,976,119**	**2,828,353**	**2,716,002**	**2,513,310**	**2,498,115**	**2,321,780**	**1,733,821**	**1,283,374**	**1,251,291**	**1,371,715**	**1,190,639**	**1,188,099**	**1,021,692**	**861,920**
Consolidated assets																
Rural operations, insurance and investments	1,115,004	598,781	506,255	466,970	476,143	470,773	486,073	458,098	211,782	196,290	181,523	200,989	180,985	177,738	205,551	139,220
Fertiliser and chemicals	539,049	548,140	485,321	406,684	343,681	381,207	323,084	251,564	254,289	248,560	285,000	301,343	272,008	203,067	158,211	174,858
Energy	1,043,829	946,265	631,495	526,299	414,318	372,205	365,479	366,012	372,071	376,170	384,680	330,175	49,782	39,253	25,751	21,264
Hardware/building and forest products	840,174	861,686	781,203	796,431	690,581	645,975	628,199	396,706	384,187	303,931						
Other	614,164	346,798	287,211	285,844	231,739	227,641	212,779	232,773	151,291	151,713	152,017	160,132	138,836	143,151	71,304	144,094
Total	**4,152,220**	**3,301,670**	**2,691,485**	**2,482,228**	**2,156,462**	**2,097,801**	**2,015,614**	**1,705,153**	**1,373,620**	**1,276,664**	**1,003,220**	**992,639**	**641,611**	**563,209**	**460,817**	**479,436**
Consolidated earnings before interest and tax																
Rural operations, insurance and investments	56,990	40,144	23,318	27,881	22,138	1,707	14,861	15,046	6,614	2,209	7,455	17,056	16,110	14,176	19,837	11,982
Fertiliser and chemicals	52,624	45,115	61,361	78,693	83,560	55,254	44,844	50,946	39,082	48,591	27,187	63,718	66,333	59,585	42,960	26,437
Energy	190,126	107,460	97,861	99,762	96,995	87,044	97,108	67,445	68,185	62,593	59,910	36,433	14,381	8,488	7,630	5,134
Hardware/building and forest products	145,876	139,977	99,141	70,108	56,840	46,818	57,191	51,814	31,603	11,285						
Other	32,375	29,666	23,869	26,293	14,583	19,395	22,099	30,293	19,524	22,482	14,127	12,756	15,087	15,456	8,429	16,180
Total	**477,991**	**362,362**	**305,550**	**302,737**	**274,116**	**210,218**	**236,103**	**215,544**	**165,008**	**147,160**	**108,679**	**129,963**	**111,911**	**97,705**	**78,856**	**59,733**
Return on assets before interest and tax																
Rural operations, insurance and investments	5.11%	6.70%	4.61%	5.97%	4.65%	0.36%	3.06%	3.28%	3.12%	1.13%	4.11%	8.49%	8.90%	7.98%	9.65%	8.61%
Fertiliser and chemicals	9.76%	8.23%	12.64%	19.35%	24.31%	14.49%	13.88%	20.25%	15.37%	19.55%	9.54%	21.14%	24.39%	29.34%	27.15%	15.12%
Energy	18.21%	11.36%	15.50%	18.96%	23.41%	23.39%	26.57%	18.43%	18.33%	16.64%	15.57%	11.03%	28.89%	21.62%	29.63%	24.14%
Hardware/building and forest products	17.36%	16.24%	12.69%	8.80%	8.23%	7.25%	9.10%	13.06%	8.23%	3.71%						
Other	5.27%	8.55%	8.31%	9.20%	6.29%	8.52%	10.39%	13.01%	12.90%	14.82%	9.29%	7.97%	10.87%	10.80%	11.82%	11.23%
Average return over all sectors	**11.51%**	**10.98%**	**11.35%**	**12.20%**	**12.71%**	**10.02%**	**11.71%**	**12.64%**	**12.01%**	**11.53%**	**10.83%**	**13.09%**	**17.44%**	**17.35%**	**17.11%**	**12.46%**





All of the real variables graphed are shown to increase post IOF. However, a subsequent decline is evident over the 1990-91 period. Wesfarmers note in relation to this period, that major international trading nations were suffering recessions or inflationary pressures, and consequently declining demand was holding down commodity prices (Wesfarmers annual report, 1991). Consequently the decline appears to be related to macroeconomic factors.

Growth and efficient use of financing

Wesfarmers, since restructuring has been able to access greater financing from the equity markets. In nominal terms positive revenues should result from the additional investments. This point is supported by in the segmentation analysis (Table 3) where a positive year-to-year change in consolidated assets[14] is associated with a positive change in revenues. However, what this does not indicate is the marginal productivity of additional capital investment but simply that higher investments are associated with more revenue.

An important question for Wesfarmers is: Are the new investments generating economies of scale or is the additional investment providing greater diversification.

[14] With one exception being 1991.

Table 4 Summary of testing of growth rates pre and post IOF.

Real growth rates	t-Crit	t-Calc	Prob.of incorrect rejection of H_0	Acceptance confidence interval	Point estimate	Prob.of incorrect rejection of H_0	Accept or reject Ho
	5% level of significance			95.8% interval			
Net profit growth rates							
t-Test assuming unequal variance	2.160	-1.120	25%				Accept H_0
t-Test assuming equal variance	2.101	-0.745	47%				Accept H_0
Wilcoxon rank sum test				(-0.1676,0.5160)	0.1314	24%	Accept H_0
Revenue growth rates							
t-Test assuming unequal variance	2.776	-1.702	16%				Accept H_0
t-Test assuming equal variance	2.101	-1.822	9%				Accept H_0
Wilcoxon rank sum test				(-0.0535,0.2567)	0.1302	12%	Accept H_0
Operating profit before abnormals and tax growth rates							
t-Test assuming unequal variance	2.447	-1.605	16%				Accept H_0
t-Test assuming equal variance	2.101	-1.371	19%				Accept H_0
Wilcoxon rank sum test				(-0.0848,0.3800)	0.1173	12%	Accept H_0
Operating profit after tax and abnormals growth rates							
t-Test assuming unequal variance	2.131	-1.2084	25%				Accept H_0
t-Test assuming equal variance	2.101	-0.717	48%				Accept H_0
Wilcoxon rank sum test				(-0.2480,0.5229)	0.1131	28%	Accept H_0
Dividend growth rates							
t-Test assuming unequal variance	2.145	-1.106	29%				Accept H_0
t-Test assuming equal variance	2.101	-0.671	51%				Accept H_0
Wilcoxon rank sum test				(-0.1215,0.4153)	0.0992	35%	Accept H_0

Conceptually diversification and economies of scale are competing forces because diversifying into industries with low or negative correlations with current firm investments will decrease economies of scale.
To test if the new financing changed Wesfarmers rate of growth, the changes in yearly growth rates pre and post IOF were tested as to whether they were statistically different. This analysis was conducted testing the real year to year continuous growth rate for net profit, revenue and operating profit. The testing was conducted using both parametric (t-tests) and non-parametric (Wilcoxon rank sum) tests and the results are summarised in table 4.

The hypotheses tested were:
H_0: That the two samples have come from the same population.
H_1: The two samples have come from separate populations.

All tests found no statistically significant evidence that the growth rates in variables investigated were different for pre and post IOF. It may be possible in future to get a longer time series of pre IOF data which may influence the analysis. The p-values for revenue growth are of interest as they are close to being significant and H_0 would have been rejected at the ten percent level of significance. Therefore even through classical hypothesis tests reject a different revenue growth rate post restructure (at the 5% significance level) there is at least some evidence that the restructure has had an impact on the revenue growth rate. From an accounting perspective, of the variables tested the revenue growth rates are least likely to be affected by manipulation and consequently evidence based on the revenue variable should be given more weighting.

The interpretation is not that Wesfarmers has not benefited from becoming an IOF, but rather the productivity of capital invested is not significantly different and there appears to be no evidence of economies of scale at the aggregate level. However, economies of scale may well be present in disaggregated investments undertaken for scale increasing activities although investments that increase diversification are likely to hide economies of scale in the aggregate data.

Share price and capital gains

The Wesfarmers share price has shown significant annual appreciation averaging[15] 17.7 percent since first listing[16] (Table 5) and has allowed the shareholders to obtain capital growth on their share investments which was a key motive in Wesfarmers restructuring. More importantly the market is able to make an unbiased assessment of the true value of the capital contribution. This is not the case in cooperatives where the value of capital contributions, especially at time of exit, is determined by the cooperative or an agent employed by the cooperative.[17] In some cases the capital is returned at the issue price.[18]

[15] The geometric average is calculated.
[16] Due to the large capital growth in the final year of this study the capital appreciation is recalculated at 13.6 percent when the final year is excluded.
[17] The ability of a single valuation to represent a 'fair' market value is questionable.
[18] Returning capital at a fair or market value is likely to increase the incentive to invest in the cooperative.

Table 5 Wesfarmers share price, capitalisation, and shares on issue (1986-2001).
Sources: Wesfarmers Investor relations and Data stream 2002
PC INFOS (RSRQ.UI90110001).

30th June	Share price ($)	Ordinary shares on issue ($m)	Stock market capitalisation ($m)	CPI deflator for Australia (standardised in 1986 prices)	Real share price ($)	Real stock market capitalisation ($m)
2001	27.09	282	7,638	1.7492	15.49	4,366
2000	13.30	260	3,507	1.6499	8.06	2,126
1999	13.60	262	3,568	1.5989	8.51	2,232
1998	11.98	251	3,012	1.5758	7.60	1,911
1997	12.51	240	3,000	1.5625	8.01	1,920
1996	7.59	229	1,737	1.5586	4.87	1,114
1995	8.91	220	1,965	1.5189	5.87	1,294
1994	8.59	198	1,699	1.4516	5.92	1,170
1993	5.78	192	1,112	1.4246	4.06	781
1992	5.89	187	1,103	1.3992	4.21	788
1991	3.70	183	675	1.3855	2.67	487
1990	3.61	177	672	1.3423	2.69	501
1989	4.30	150	659	1.2513	3.44	527
1988	3.50	144	579	1.1633	3.01	498
1987	2.05	122	250	1.0849	1.89	230
1986	1.35	90	122	1.0000	1.35	122

Wesfarmers financials Summary

The ratio analysis performed identified that Wesfarmers efficiency, as indicated by the inventory turnover and the ability of assets to generate sales, has diminished. However, the profitability measures showed strong performance with the return on equity averaging 14.5 percent, and found profitability to be quite stable possibly due to the diversification strategy. Of most concern were the solvency measures that found Wesfarmers liquidity to be below critical levels. The financial gearing has increased from approximately $1 to $1.50 for dollar of equity since restructuring. This indicates that debt is the preferred source of financing for Wesfarmers. The market ratios analysis is supportive of a market that perceives Wesfarmers as having future growth potential.

The parametric and non-parametric testing found no statistically significant evidence that the growth rate in variables investigated was different between pre and post IOF although the possibility that the revenue growth rate has changed could not be totally ignored. The transformation into an investor-owned company has allowed shareholders to obtain capital growth on their share investments which was a key issue in Wesfarmers purpose of restructuring. Notably listing allowed the market to make an unbiased assessment of the true value of the capital contribution of past cooperative members.

CONCLUSIONS

The conclusions from the analysis performed are divided into two sections; the first section is conclusion in regard to cooperative theory and finance theory; while the second part of the conclusions relate to the Wesfarmers case study.

Conclusions from cooperative and finance theory

Restricting the return of farmer's capital contributions is counter productive and combined with a muddled objective function of cooperatives, may cause members to imit the cooperative's capital retentions and jeopardize the cooperative performance and the growth opportunities.[19]

The equity return and member only equity contributions of cooperatives operate outside the competitive capital market setting.[20] Therefore agency costs will be higher than those of an IOF.

Motivations to form agricultural cooperatives appear to be more a function of risk aversion, than the desire to select an industry structure that would maximise potential welfare gains for an entire economy. In addition, when the ownership is held by the suppliers whose activities represent only a small portion of the cooperative turnover, the value of the protection provided to the assets invested, will be less than the agency costs of the cooperative structure.

Investor-owned firms have the potential to improve economic outcomes by providing greater competition, improved market signals, more efficient use of financing, and therefore improve allocative efficiency.

Conclusions from the Wesfarmers case study

Wesfarmers have increased their access to the equity markets and their shareholders have obtained capital growth on their investment. In addition, the leveraging of equity investment has unlocked additional value for the shareholders.

Wesfarmers is an example of an agricultural business that has embraced the commercial disciplines of an IOF. However, the diversified investments of the original cooperative (inter-industry) reduce asset specificity and therefore the potential loss from evolving into a IOF.[21]

[19] Growth is used in the context of being able to undertake investment opportunities at the market cost of capital.
[20] Significantly in New Zealand there is no real competitive option outside of Fonterra for dairy farmers.
[21] The 'potential loss' being the protection of farm specific investments by cooperative members.

Implications for future research

Investigating the relationship between the value of member supply and the total returns[22] of the cooperative could provide further insights into the point when it is optimal to restructure into an IOF. In addition, the divergence between the book value of cooperative assets and the value of expected future returns would be of similar interest.

The Wesfarmers case study could be extended to include the financial performance prior to becoming an IOF. However, changes in performance may not be a result of a change in the ownership structure but rather an indication of the prevailing economic climate. Moreover, benchmarking Wesfarmers performance to other agricultural businesses could provide more insightful results. In addition further analysis would enable a more detailed understanding of Wesfarmers restructuring motives, and how they are similar and dissimilar to other cooperatives that have evolved into IOF's.

[22] Effectively a proxy for the diversification and value added by the cooperative.

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THE COST OF FOOD SAFETY REGULATION: AN ANALYSIS OF THE EFFECTS ON VARIABLE COST OF PRODUCTION OF THE NEW ZEALAND RED MEAT INDUSTRY

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Abstract

Consumer concerns about food safety heightened by recent food scares and food-related illnesses have led to the introduction of new food safety regulation. In recent years, Hazard Analysis and Critical Control Points (HACCP) has been and being mandated by governments all over the world. In New Zealand, the Animal Product Act 1999 requires all animal product processing businesses to have a HACCP-based program by the end of 2002. The fact that HACCP is a preventative control method with great flexibility has made it a popular choice. However, there are also concerns over the impacts the program will have on the food industry. This paper attempts to measure the effects of such regulation on the variable cost of production of the red meat industry, using the framework developed by Antle (2000). A model of quality-adjusted translog cost function is estimated using census of manufacturing data from 1929 to 1984. This allows us to estimate the elasticity of cost with respect to safety, which is then used to calculate the increase in variable cost due to regulation. Our results show that variable costs could increase from 4 cents to 68 cents per kilogram. The paper is constructed into 4 parts. Part I provides a review of types of compliance costs and methods to quantify them. Part II discusses the theoretical framework, data, model, and estimation. Results are discussed in part III. Part IV concludes the paper and provides implications for further research.

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1. Food safety regulation and industry compliance costs

The introduction of food safety regulation

Safety is a quality attribute of foods, along with other attributes such as nutrition, value (e.g. taste), package, and process (e.g. animal welfare) (Caswell et al, 1998). However, unlike other quality attributes, safety information is often imperfect. Food safety is usually not discernible to consumers at the time of purchase. When producers have knowlegde about the safety of foods but consumers do not, the food market has a problem of *asymmetric information*. There are also many cases where even producers have imperfect information about food safety, for example when microorganisms enter the food chain, then there is also a problem of *symmetric imperfect information* (Antle, 2000). It is the lack or high cost of information about food safety which makes the market fail to achieve an efficient level of safety, thus provides a motivation for government regulation (Unnevehr and Jensen, 1996; Antle, 1996).

Huge costs to society due to foodborne illness and recent food scares, such as hamburger contaminated with E Coli in the US and Mad Cow Disease in the UK, have made regulators review old food safety regulation systems and introduce new regulations. In the USA, new regulation such as HACCP has been mandated for the seafood industry since 1995 and for meat and poultry since 1998. Needless to say, food regulations of food exporting countries are also influenced by regulations of its trading partners. In New Zealand, HACCP-based risk management programmes are required for animal product processing businesses under the Animal Products Act 1999.

The cost of food safety regulation

Social costs of regulation, or food safety regulation in particular, can be divided into three categories: industry compliance costs, social welfare lossess, and transitional social costs (Unnevehr and Jensen, 2001). Table 1 shows the sub-categories and examples of these costs.

Table 1. Social costs of food safety regulation

Social Cost Category	Sub-categories	Examples of HACCP costs
Industry Compliance Costs / Direct Costs	- One-time start-up costs	- HACCP plan design and employee training
	- Variable costs	- Additional labour and materials, costs of testing for pathogens
Social Welfare Losses	- Higher consumer/producer prices which lead to changes in consumer/producer surplus	- Higher prices for meat products
	- Administrative costs	- HACCP administration costs
Transitional Social Costs	- Firm closing	- Small firms exit
	- Resources shift to other markets	- Reduction in the numbers of products
		- Regional shift in meat production

This paper focuses on the direct costs of food safety regulation or industry compliance costs. Approaches to measure this type of costs are discussed in the next section.

Quantifying industry compliance costs

Antle (1999) discussed three approaches to quantify the direct costs of food safety regulation: (1) accounting approach; (2) economic-engineering approach; and (3) econometric approach.

In the accounting approach, costs are identified and calculated, without estimating a parametric representation of the cost function. Therefore, according to Antle (1999), this method is unlikely to provide estimates of average costs for the whole industry due to the limited number of plants surveyed. Moreover, the accounting approach often underestimated costs as the method is unable to measure effects of regulation on the overall operating efficiency of a plant. Examples of studies using the accounting method include: the study of the Food Safety Inspection Service (FSIS) on the costs of HACCP to the US meat and poultry industry (Crutchfield et al, 1997) and the study of Colatore and Caswell on costs of HACCP to the US breaded fish industry (Colatore and Caswell, 2000).

The economic-engineering approach is described by Antle (1999) as a method using detailed engineering data combined with data on input costs to construct a quantitative model of the production process. This approach can provide a detailed picture of a plant's production process but it is costly to implement for each plant studied. Therefore, it may fail to capture the heterogeneity of the industry and may not provide cost information that is representative of the industry. The study of Jensen and Unnevehr (2000) on cost of implementing HACCP to the US pork industry provides an example of this approach.

In the econometric approach, cost functions are estimated and estimation results are then used to measure potential costs of regulation. Although the method can not provide cost details as in the other two methods, its advantages are that the cost function can capture the actual production behavior of the firm and provide a statistical basis to test for related hypotheses. Moreover, regulatory impacts on productive efficiency can be measured. Antle (2000) has provided a detail framework of using this approach to measure the cost of HACCP to the US meat and poultry industry.

This study attempts to use the econometric approach as developed by Antle (2000) to measure the impacts of a food safety regulation such as HACCP on the variable cost of production of the New Zealand red meat industry. The unique feature of this study is that we use time series data, which allows technical change to be considered.

2. Theoretical framework, empirical model, data, and estimation of quality-adjusted cost function

Theoretical framework

Antle (1999) showed that production cost can be divided into three components: (1) a variable cost component which depends on both output and product quality, (2) a seperate variable cost component which depends on quality but is independent of output, and (3) a fixed cost component. Hence, if we characterised the quality-differentiated product by the triplet (y,s,**q**), where y is output quantity, s is product safety, and **q** is a vector of other non-safety quality attributes; then the cost function for a production process with quality control can be specified as:

$$C(y,s,\mathbf{q},\mathbf{w},k) = vc(y,s,\mathbf{q},\mathbf{w},k) + qc(s,\mathbf{q},\mathbf{w},k) + fc(k) \qquad (1)$$

where

w is a vector of input prices

k is the value of capital stock

vc(.) is the variable cost component that depends on both product quantity y and product quality s, **q**

qc(.) is the other variable cost component that is independent of y but depends on s and **q**

fc(k) is the conventional fixed cost component

The accounting method normally just account for the impacts of regulation on the cost components qc(.) and fc(.). Therefore, it is the purpose of this paper to measure the impacts on vc(.) or the productive efficiency impacts of food safety regulation.

The classical cost function usually does not account for product quality. The reason is that quality is normally treated as fixed in the short run. Additionally, many quality attributes are not readily observed and measured (Gertler and Waldman, 1992). Antle (2000), following Gertler and Waldman (1992), has developed a model with an unobserved scalar safety variable whose parameter can be estimated using other observable variables.

To derive a measure for unobserved safety variable, Antle (2000) utilized a model of a market in which price-taking firms produce a quality-differentiated product. While this assumption might require careful consideration in a highly concentrated market, it seems reasonable for the New Zealand experience, where exporting firms are price-takers in international markets.

Let product demand be described as $Y^D = D(P,S,\mathbf{Q},\mathbf{Z})$, where P is output price, S is product safety, **Q** is a vector of other quality attributes, and **Z** is a vector of other demand variables. Y^D is increasing in desirable quality attributes, e.g derivative with respect to S, $D_S > 0$. Market supply is given by $Y^M = M(P,S,\mathbf{Q},\mathbf{W},K)$ where **W** is a vector of input prices and K is the industry capital stock. Y^M is decreasing in quality attributes, e.g $M_S < 0$. As S is not observed, equating Y^D and Y^M to solve for S, we have:

$$S = F(\mathbf{Q},P,\mathbf{Z},\mathbf{W},K) \qquad (2)$$

which has the following properties:

- F(.) is increasing in price: $F_P > 0$
- Derivative with respect to elements of **Q:** $F_Q < 0$ for a given product price
- Derivatives with respect to elements of Z are opposite in sign from the derivatives of the demand function, and
- Derivatives with respect to W and K have the same sign as the derivatives of the supply function with respect to these variables.

Quality-adjusted translog cost function

Recall that the theoretical variable cost component, which depends on both product quality (s, **q**) and quantity y, is defined as vc(y,s,**q**,**w**,k). Here, **q** is a vector of other non-safety quality attributes. Following Antle (2000), we use management intensity (q_{man}), which is defined as the ratio of non-production labor to production labor, as a non-safety quality variable. The other quality variable (q_{mix}), which measures the proportion of processed product in total output, as used by Antle (2000) is not considered in this study due to data unavailability. This can also be explained by the

fact that most meat processing businesses in the studied period specialized in either slaughtering or packaging[1]. Hence, defining input variable as consisting of labor (L) and other materials (M)[2] and assuming neutral technical change, the empirical variable cost function is specified as follows:

$$\begin{aligned}\ln VC = {} & \alpha_0 + \alpha_M \ln w_M + \frac{1}{2}\alpha_{MM}(\ln w_M)^2 + \alpha_L \ln w_L + \frac{1}{2}\alpha_{LL}(\ln w_L)^2 + \beta_y \ln y + \frac{1}{2}\beta_{yy}(\ln y)^2 \\ & + \delta_k \ln k + \frac{1}{2}\delta_{kk}(\ln k)^2 + \alpha_{ML}\ln w_M \ln w_L + \beta_{yM}\ln y \ln w_M + \beta_{yL}\ln y \ln w_L + \beta_{yk}\ln y \ln k + \\ & + \delta_{kM}\ln k \ln w_M + \delta_{kL}\ln k \ln w_L + \gamma_s \ln s + \gamma_{sM}\ln s \ln w_M + \gamma_{sL}\ln s \ln w_L + \gamma_{sy}\ln s \ln y + \\ & + \gamma_{sk}\ln s \ln k + \theta_{man}\ln q_{man} + \beta_t t + \beta_{tt} t^2\end{aligned} \tag{3}$$

where

k is the value of capital stock at the beginning of the year

t is a time variable which captures change in technology over time. The associated parameters are expected to have negative sign due to technical progress.

Following Antle (2000), the second-order term of safety and other quality variables are omitted in order to reduce the number of parameters and the potential collinearity caused by large number of variable interactions in the unrestricted model.

If assuming non-neutral technical change, the cost function is then specified as follows:

$$\begin{aligned}\ln VC = {} & \alpha_0 + \alpha_M \ln w_M + \frac{1}{2}\alpha_{MM}(\ln w_M)^2 + \alpha_L \ln w_L + \frac{1}{2}\alpha_{LL}(\ln w_L)^2 + \beta_y \ln y + \frac{1}{2}\beta_{yy}(\ln y)^2 \\ & + \delta_k \ln k + \frac{1}{2}\delta_{kk}(\ln k)^2 + \alpha_{ML}\ln w_M \ln w_L + \beta_{yM}\ln y \ln w_M + \beta_{yL}\ln y \ln w_L + \beta_{yk}\ln y \ln k + \\ & + \delta_{kM}\ln k \ln w_M + \delta_{kL}\ln k \ln w_L + \gamma_s \ln s + \gamma_{sM}\ln s \ln w_M + \gamma_{sL}\ln s \ln w_L + \gamma_{sy}\ln s \ln y + \\ & + \gamma_{sk}\ln s \ln k + \theta_{man}\ln q_{man} + \beta_{Mt}\ln w_M t + \beta_{Lt}\ln w_L t + \beta_{yt}(\ln y)t + \beta_{kt}(\ln k)t + \beta_{st}(\ln s)t + \\ & + \beta_t t + \beta_{tt} t^2\end{aligned}$$

[1] Meat processing is categorized into: export meat works and abattoirs, other/rural abattoirs, and meat packers.

[2] Other materials include: Animal, Energy, and other Materials purchases.

Applying Shephard's lemma, the first-order condition for labor input is:

$$C_L = \alpha_L + \alpha_{LL}\ln w_L + \alpha_{ML}\ln w_M + \beta_{yL}\ln y + \delta_{kL}\ln k + \gamma_{sL}\ln s \tag{4}$$

in the case of neutral technical change

Or

$$C_L = \alpha_L + \alpha_{LL}\ln w_L + \alpha_{ML}\ln w_M + \beta_{yL}\ln y + \delta_{kL}\ln k + \gamma_{sL}\ln s + \beta_{Lt} t$$

in the case of non - neutral technical change

Here,

C_L is the labor cost share.

The conditions for linear homogeneit y of the cost function are :

$$\alpha_M + \alpha_L = 1 \tag{5}$$

$$\beta_{yM} + \beta_{yL} = 0 \tag{6}$$

$$\gamma_{sM} + \gamma_{sL} = 0 \tag{7}$$

$$\delta_{kM} + \delta_{kL} = 0 \tag{8}$$

$$\alpha_{Mj} + \alpha_{Lj} = 0 \quad \text{where} \quad j = M, L$$

Also, as α_{ij} is symmetric, we have :

$$\alpha_{MM} = \alpha_{LL} = -\alpha_{LM} = -\alpha_{ML} \tag{9}$$

The theoretical quality function (2) is written in log-linear form as:

$$\ln s = \tau_0 + \tau_p \ln p + \tau_{man}\ln q_{man} + \tau_Z \ln Z + \tau_M \ln w_M + \tau_L \ln w_L + \tau_k \ln k \tag{10}$$

where

p is output price,

q_{man} is management intensity, which is the ratio of non-production labor to production labor,

k is capital stock at the beginning of the year

w_M, w_L are prices of materials and labor respectively, and

Z is a demand variable, here we use per capita income as Antle's study shows that other demographic variables are highly correlated with income, and that estimation using per capita income produces the lowest estimate of costs.

Following Antle (2000), we use two restrictions with the quality equation. First, $\tau_0 = 0$ as the intercept in this case cannot be identified. Second, $\tau_p = 1$ as derivative with respect to p is positive and the units of safety cannot be defined.

Production data for meat industry taken from census of manufacturing in the period 1929-1984 is used for estimation. CPI deflators are taken from New Zealand Official Yearbook 2000. New Zealand per capita income for the period is taken from Maddison (1995). A statistical summary of the variables is presented in Table 2.

To estimate the system of cost and cost share function, equation (10) is substituted into (3) and (4). Then the system is estimated with linear homogeneity restrictions (5)-(9) imposed using the nonlinear seeming unrelated regression routine in Shazam. We estimate the model for both neutral and non-neutral technology change. Results are presented in Table 3.

Table 2. Statistical summary of variables (prices in 1999 dollars)

Variable	Unit	Obs.	Mean	Standard Deviation	Minimum	Maximum
w_M	PPI* (base 1982=1000)	52	229.92	225.00	67.00	1317.00
w_L	$ (000)	52	19.45	11.01	7.67	40.01
y	Tonnes(000)	52	637.32	331.46	191.25	1234.30
k	$ (000)	52	622,260	676,760	150,190	2,604,800
q_{man}	-	52	0.14	0.018	0.07	0.18
P	$ per tonne	52	3123.70	1057.60	1846.30	6311.40
Z	1990internl $	52	8804.40	2702.90	4349.00	13891.00
VC	$ (000)	52	2,051,600	1,556,100	412,380	6,436,300
C_L	-	52	0.17	0.095	0.09	0.50

* Producer Price Index

Table 3. Estimation results (t-ratio in brackets)

Variable	Neutral Technical Change	Non-neutral Technical Change
α_0	-7.09	24.04
	(-1.95)*	(1.79)*
α_L	0.55	1.38
	(3.49)***	(4.44)***
γ_S	1.07	-2.33
	(2.73)***	(-2.32)**
τ_M	-0.9	-0.84
	(-18.13)***	(-13.56)***
α_{LL}	0.018	0.050
	(0.94)	(2.69)***
γ_{SL}	-0.17	-0.19
	(-10.58)***	(-12.21)***
τ_L	-0.098	-0.06
	(-1.71)*	(-1.018)
β_y	2.89	-4.48
	(3.73)***	(-1.21)
β_{yy}	-0.53	0.41
	(-2.80)***	(0.60)
δ_k	0.49	-0.93
	(1.079)	(-0.73)
τ_k	-0.038	-0.31
	(-0.79)	(-6.21)***
δ_{kk}	-0.089	-0.013
	(-3.025)***	(-0.21)
γ_{sk}	0.052	0.16
	(1.054)	(3.25)***
β_{yL}	-0.14	-0.23
	(-10.96)***	(-7.13)***
γ_{sy}	-0.18	0.25
	(-2.024)**	(1.68)*
β_{yk}	0.11	0.24
	(1.20)	(1.87)*
δ_{kL}	0.078	0.008
	(9.11)***	(0.59)
τ_{man}	-0.21	-0.20
	(-1.74)*	(-2.05)**
θ_{man}	0.30	0.26
	(2.55)**	(3.15)***
τ_z	-0.40	-0.05
	(-0.65)	(-0.75)
β_t	0.0041	0.22
	(0.85)	(1.47)
β_{tt}	0.00017	0.00029
	(1.65)	(0.52)
β_{Mt}	-	-0.0083
		(-3.25)***
β_{st}	-	-0.026
		(-3.69)***
β_{Lt}	-	0.0047
		(2.82)**
β_{kt}	-	-0.0037
		(-0.55)
β_{yt}	-	-0.026
		(-1.03)

*, **, ***: significant at α= 0.1, 0.05, and 0 .01 respectively

3. Discussion and estimation of cost of regulation

To confirm that safety does affect productive efficiency, we conduct a test for the hypothesis of safety exogeneity. For the cost function (3), safety exogeneity holds if and only if γ_S and γ_{Si}, i = y, M, L, k are all equal to zero. Our test results strongly reject this hypothesis (p = 0).

Results with neutral technical change are quite different from those with non-neutral technical change. Estimation with neutral technical change does not show any technical progress (β_t and β_{tt} are both positive). However, the mean of cost elasticity with respect to technical change in the case of non-neutral technical change is negative (-0.063) which shows technical progress over time. Therefore, for all other estimation followed, we use the estimation results of the cost function with non-neutral technical change.

Overall, most coefficients are significant at conventional levels (α = .1, .05, and .01). The interaction term of safety and labour price γ_{sL} is negative which means that higher labor price lowers marginal cost of safety. On the contrary, as γ_{sM} has opposite sign from γ_{sL}, higher material price leads to higher marginal cost of safety. These results are similar to those found by Antle (2000) with the US meat industry. The interaction term of safety and capital γ_{sk} is positive which means that increasing capital stock leads to increasing marginal cost of safety. Also, γ_{sy} is positive means that higher rates of production are associated with higher marginal cost of safety.

The interaction term of time and material β_{Mt} is negative which shows that technical change is material saving. On the contrary, β_{Lt} is positive which implies that technical change is labor using. Moreover, β_{st} is negative which shows that marginal cost of safety decreases as technology progresses.

To estimate impacts of food safety regulation on variable cost, elasticity of cost with respect to safety is calculated. We calculate elasticity at each observation and then calculate the mean. Results show safety cost elasticity lie in the range of 0.907 to 1.306, with a mean to be equal to **1.06**. The fact that mean safety cost elasticity is positive shows that cost of production rises as the safety level increases. This result is somewhat higher than that of the US meat industry, which is around 0.7 for beef

plants. As this is the result associated with the production technology of the period from 1929 to 1984, the estimates are subsequently adjusted to take into account technical change in the period since 1984.

To estimate the cost of food safety regulation, Antle (1999) has presented a theoretical framework for measuring impacts of both performance standards and process standards. HACCP as a pathogen reduction regulation for meat and poultry is viewed as a combination of design (process) standard and performance standard (Unnevehr and Jensen, 1996; Antle, 1999). Changes in variable cost of production due to a food safety regulation such as HACCP are then calculated as follows:

$$\Delta VC = VC.E.e.(100-S)/S \qquad (11)$$

where

VC is the level of variable cost of production. Here we take the mean of variable costs during the period, mean VC = 2,051,600,000 (1999 dollars).

E is the mean of safety cost elasticities, E = 1.06 as calculated above.

e is the effectiveness of the regulation in enhancing food safety (or reducing microbial pathogen as in the case of HACCP), following Antle (2000), we assume e = 20 %.

S is the level of product safety before the introduction of the new regulation, here S is defined as the percentage of negative outcomes when product is tested for microbial contamination in a unit of time. ($0 < S \leq 100$)

The cost per unit can be calculated as:

$$u = \Delta VC/y \qquad (12)$$

Where y is output volume, y = mean output = 637,320 (tones).

We calculate change in variable cost and the resulted unit cost for three scenarios: S = 50%, 70%, and 90%. Results are presented in Table 4.

Adjustment for technical change

The results discussed above represent the state of technology during the period 1929-1984. However, as technology progresses, the elasticity of cost with respect to safety will also change. Estimation results of the cost function with non-neutral technical change show a negative interaction between safety and time (βst = -0.026). This indicates that marginal cost of safety decreases as technology progresses. Assuming nothing else changes, safety cost elasticity could reduce as much as 0.47 (which is 0.026*18years). Therefore the safety cost elasticity of the present time is estimated to be **0.55** (which is elasticity of 1984 minus 0.47). Although this might seem a naïve approach, it does allow us to reach an estimation of the safety cost elasticity of the present time, given the data set used. Changes in variable cost and unit cost of safety associated with this adjusted elasticity are presented in Table 4.

Table 4. Increases in variable cost of production and unit cost of safety for a 20% improvement in product safety (in 1999 dollars)

Scenario	Safety Elasticity = 1.06	Adjusted Elasticity* = 0.55
Base safety S = 50%		
Increase in cost (ΔVC)	434,338,000	225,138,000
Unit cost (u) ($/kg)	0.68	0.35
Base safety S = 70%		
Increase in cost (ΔVC)	186,145,000	96,488,000
Unit cost (u) ($/kg)	0.29	0.15
Base safety S = 90%		
Increase in cost (ΔVC)	48,260,000	25,015,000
Unit cost (u) ($/kg)	0.076	0.039

*Adjusted to take into account technical change since 1984

Estimation results show that for a mean of variable cost of about $2 billion, increase in variable cost due to regulation could be in the range of $25 million to $400 million (or 1.25% to 20% respectively). Cost per unit could be in the range of **4 cents** to **68**

cents per kilogram. The lower bound of estimation is surprisingly compatible with Antle's estimations of US beef plants, which range from 1.9 cents per pound to 17 cents per pound. Our estimation range is larger as we include the scenario when production technology stays as the same as that of 1984.

4. Conclusion

Using Census of Manufacturing data from 1929 to 1984, we have estimated a model of quality-adjusted translog cost function for the New Zealand red meat industry. Estimation results are then used to measure the increase in variable cost of production due to the introduction of a food safety regulation such as HACCP. The elasticity of cost with respect to safety is estimated to be 1.06 for the study period. Due to technical progress, the safety cost elasticity could reduce to 0.55 at the present time. Therefore, for a level of annual variable cost of about $2 billion, increase in variable cost is estimated to be in the range of $25 million to $400 million (1.25% to 20%). Cost per unit is estimated to be in the range of 4 cents to 68 cents per kilogram. This cost represents the impacts of regulation on the operating efficiency of firms. For a regulation like HACCP, these could be additional variable costs associated with the slowdown of slaughtering line due to monitoring, sampling and testing. These costs constitute just a part of the total cost of HACCP which includes other items such as costs of HACCP plan design, labor training, new investment equipment, and costs of validation and record-keeping. A study of the US Food Safety Inspection Service estimates these costs (costs which are independent of output volume) to be US$100 million per year (Antle, 2000).

We conclude our paper with some implications for further research:

1. Similar estimation can be done for cross-sectional data or panel data. In fact, cross-sectional data and panel data could provide more detailed data on firm production processes and allow the use of other quality variables. Also, the effects of data aggregation would be less given the availability of plant-level data. Additionally, we could be able to distinguish the impacts on different firm sizes.

2. The accuracy of estimation could be higher if data on the effectiveness of HACCP as well as data on the safety base level of plants are available.

3. Finally, an up-to-date data set, if available, would be able to bring an up-to-date estimation of the safety cost elasticity. This suggests, given the unavailability of census of manufacturing data, the conducting of a survey for the New Zealand meat industry.

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Recent trends in dairy farm productivity[1]

By

Ann Anderson and Robin Johnson[2]

Dexcel Limited have recently commissioned an investigation into dairy farm productivity among owner operators and 50/50 sharemilkers. This paper reports on the results and some implications for national dairy farming policy. Data is drawn from the Economic Survey of New Zealand DairyFarmers and productivity measures are based on moving average weighted index numbers. There has been a steady growth in productivity in both samples since 1994; total input productivity increased by 2.4% per annum for owner operators and 4.7% per annum for 50/50 sharemilkers. The results have policy implications for the growth targets for the industry set in the McKinsey report on the dairy industry.

Introduction

The McKinsey Report on the dairy industry noted the low rate of productivity growth in the farm sector and that the movement had been negative in some seasons. The Report sets an objective for productivity growth of 4% per year over the whole industry. Such an objective could only be obtained by growth in output without a corresponding growth in resources used or by the same output with less resources. In periods of heavy investment in purchased inputs and capital improvements productivity improvements could be delayed for some years.

In this paper trends in productivity growth in the farm sector are analysed. The methodology employed will be described first followed by a summary of the main results. The statistical analysis is discussed in the technical appendix.

Measuring Productivity

Productivity measures are sought for the owner operator sector of the dairy industry and the 50/50 sharemilker sector. The data is drawn from the Economic Survey of New Zealand Dairy Farmers (Dexcel Limited 2001).

The aim of productivity measures is to isolate changes in physical efficiency in production. Essentially this involves deriving consistent measures of production on the one hand, and the accompanying real resources that are used in the process of production, on the other.

Productivity is measured at the whole farm level. Total output is all that a farm produces, and input covers all resources that are used on the farm, viz. purchased inputs, labour employed or assessed, and land resources.

[1] Paper presented to the New Zealand Agricultural and Resource Economics Society, July 5-6, 2002, Blenheim.

[2] Economic Survey Manager, Dexcel Corporation, Hamilton, and Consulting Economist, Wellington, respectively.

Physical productivity measures require all survey data to be converted to its physical equivalent. Survey data is normally recorded in current prices hence the effect of inflation is incorporated in the data. This has to be removed by deflating the survey data by price indexes related to the individual categories of products produced and inputs used. In this report, price indexes from Statistics New Zealand and Quotable Value New Zealand are utilised.

All production data and input data is converted to a set of index numbers. Weighting systems have to be employed where a group of products (with different prices) make up total production and where a group of inputs (with different prices) make up total inputs. The weighting system used in this analysis is a chain linked index number methodology named after a statistician called Tornqvist. Details are shown in the technical appendix.

To apply this methodology, the weights for each input and product category are derived according to actual cost or value. The weights are the value shares that each input or output bears to its total value. In the case of the input of labour and capital, it is assumed that all wages and wages of management (as assessed in the production survey) are paid and any residual income is identified as the going reward for the capital investment involved.

It is argued that dairy farmers carry out their activity for the labour reward and accept a very low real return on capital employed. In the case of 50/50 sharemilkers, the return on capital (exclusive of capital appreciation) is negative in most years after allowing for the full cost of their labour.

Definitions

Total output is the sum of all products shown in the farm surveys. Each product category is deflated by its relevant price index to determine real total output, i.e. total output at constant prices. To form an index of total output produced, the real changes of the components of total revenue (i.e. milk sales, livestock sales etc) are brought back together and weighted in accordance with their share of total revenue.

Total input is the sum of all purchased inputs (excluding wages) and the estimated total cost of labour and capital assets. It excludes depreciation and interest paid. Each input category is deflated by its own price index except labour use and capital cost. Labour use is measured by total labour units as determined by Dexcel and capital use is measured by the deflated value of the farm assets. Land and buildings are deflated by the average price of dairy farm land as estimated by Quotable Value New Zealand. Livestock capital and farm equipment are deflated by appropriate index numbers from Statistics New Zealand. The index of total input use is derived by bringing all the components together and weighted in accordance their share of total cost.

Total productivity (TP) is the ratio of weighted total output to weighted total input.

Factor shares are the proportions in value terms that individual outputs and inputs relate to total values. These are the basic weights in the index number formulas.

The index number formula is given in the appendix to this paper.

Results

Chart 1 shows the key results for the owner-operator sample. Table 1 shows the broad trends broken down into annual percentage changes. At the foot of the columns are the average growth rates of change. Average annual growth rate formulas are discussed in the technical appendix.

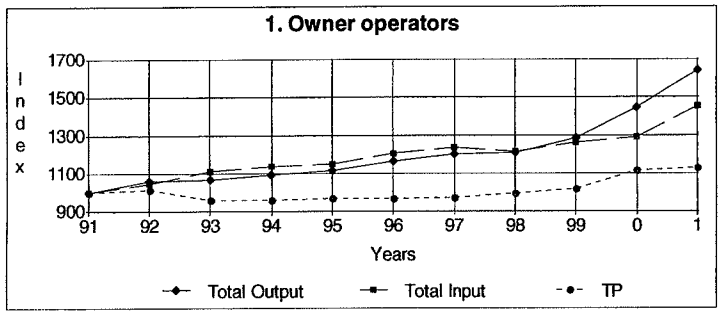


Table 1: Productivity Changes for Owner Operators
(percentage change)

Season	Output	Input	TP
1990-91	-	-	-
1991-92	+6.2	+4.7	+1.5
1992-93	+0.7	+6.3	- 5.4
1993-94	+2.3	+2.3	+ 0
1994-95	+2.1	+1.1	+0.9
1995-96	+4.4	+4.8	- 0.2
1996-97	+3.2	+2.6	+0.5
1997-98	+0.6	- 1.7	+2.4
1998-99	+6.4	+3.9	+2.4
1999-00	+12.2	+2.2	+9.7
2000-01	+13.6	+12.4	+1.2
Ave % growth rate	+4.1	+3.0	+1.1

The 1990s were characterised by a steady growth in output with a spurt toward the end of the decade. In the early years, the use of resources increased faster than output and depressed productivity growth. Average farm size and herd size were both

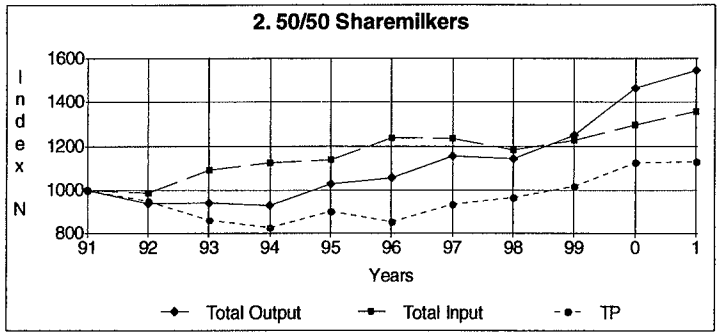
expanding through the decade. Some of the later growth in output is due to earlier investment by the farmers.

Over the period analysed, productivity has increased by 1.1% per year on average for owner operators. There is marked variation between years. In some years, the productivity trend is determined by changes in production and in others by changes in the use of inputs (costs). Since 1994, the rate of growth has been 2.4% per year.

In the seasons 1992-93 and 1997-98, production of milk was static due to seasonal conditions. In the seasons 1991-92, 1992-93 and 1995-96 there were substantial increases in costs due to increased supplementary feeding, fertiliser use, and animal health expenses. As a result, the rate of increase of real costs exceeded the rate of increase of production and productivity fell sharply or increased by only a small amount.

50/50 Sharemilkers

Chart 2 shows the overall trends for the 50/50 sharemilker sample. Table 2 shows the key results expressed as annual percentage changes..

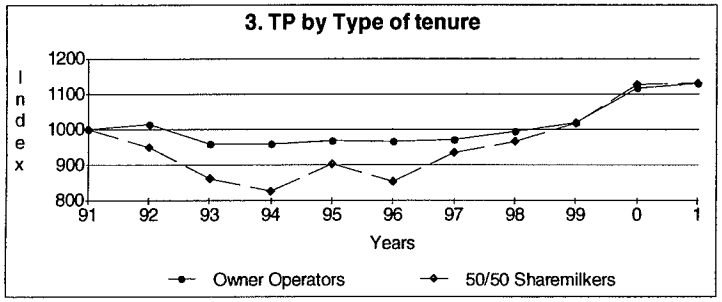


On 50/50 sharemilker farms, the growth in production has been greater than in owner operator farms. But like owner operators, the early 1990s saw greater growth in the use of resources than in output. As a result, the productivity measures fell in the early 1990s but then started to rise quite rapidly from 1995-96 (See Chart 3).

The average rate of change in total productivity has been considerably higher in the sharemilker sample. However, the response to seasonal conditions is different in the two samples. Lower livestock sales caused a drop in weighted output in the 50/50 sharemilkers in 1991-92 and 1993-94. Increased feeding costs caused an increase in total input in 1992-93 and 1995-96 particularly. As a result the changes in TP in the 50/50 sharemilkers sample from year to year are more extreme. Since 1994 the rate of growth has been 4.7% per year.

Table 2: Productivity Changes for 50/50 Sharemilkers
(percentage change)

Season	Output	Input	TP
1990-91	-	-	-
1991-92	- 6.1	- 1.2	- 5.0
1992-93	+0.3	+10.6	- 9.3
1993-94	- 1.3	+3.0	- 4.2
1994-95	+10.6	+1.2	+9.3
1995-96	+2.7	+8.6	- 5.4
1996-97	+9.4	- 0.2	+9.3
1997-98	- 1.0	- 4.2	+3.4
1998-99	+9.2	+3.6	+5.3
1999-00	+17.0	+5.7	+10.7
2000-01	+5.6	+4.6	+0.4
Ave % growth rate	+4.8	+2.9	+2.0



The two samples differ in structure in their cost patterns and capital employed. Fertiliser cost is much lower for sharemilkers and hence influences the result less. The capital employed by sharemilkers is also much lower (land and buildings not being their responsibility) hence changes in this element do not influence their result as much. Labour costs are about the same as Dexcel estimates them the same way. But since sharemilkers wages are a higher proportion of the value of production, changes in labour use have more influence on the productivity estimates. Changes in capital employed have a relatively low weight in both samples.

Comparison with other studies

It is of some interest to compare the dairy results with other types of farming. Forbes and Johnson (2000) show that the national average growth in total productivity was

1.8% per annum in the period 1985-98. Table 3 shows the result of a study by Philpott (1994) comparing total factor productivity in dairy with sheep farming and horticulture. Philpott uses national estimates of factor income, factor inputs, labour employed and capital employed and weights all inputs by their average factor share value.

In the period 1983-93 the horticulture sector was going through an expansion phase and contributed the most to national total factor productivity growth. Sheep farming and dairy farming were much lower in productivity growth. Sheep farming was declining in importance in this period; dairy farming was on a moderate expansion path.

Table 3. Dairy factor productivity and type of farming
(growth rates)
1983-93

	Factor Input	Factor Output	TFP
		(% per year)	
Sheep	- 1.7	- 0.8	0.8
Dairy	1.4	1.8	0.5
Horticulture	4.6	9.5	4.7
ALL FARMS	0.1	2.1	2.1

(Source: Philpott 1994)

Note: These rates of growth are rounded.

Discussion

On the output side, milk income is the dominant product category. Livestock sales as a source of income tends to be rather erratic in the survey results. For further farm management analysis, therefore, total output of milk solids will continue to be a good proxy for total production or output.

On the input side, the driving force is purchased inputs. Factor inputs are relatively static. The down turn in productivity in the early 1990s was due to increased use of pasture and supplements and fertiliser in the owner operator sample. (Pasture and supplements includes hay, silage, meal, cropping, pasture renovation, grazing and contractor costs). In the 50/50 sharemilker sample, there was increased spending on animal health, pasture and supplements and fertiliser.

It will always be possible for a reversal in the productivity trend when the growing seasons are poor or drought spreads across the main dairy producing regions.

There is some evidence from other studies that farm investment takes a period of time to bed down before productivity results are apparent (Forbes and Johnson 2000). In the production survey most of this capital expenditure is not shown directly as the

input records are based on farm accounts. However, it is clear in a season like 2000-01, when payouts reached record levels, that farmers were spending their increased revenue on capital improvements like increased fertiliser applications, which will benefit production levels in following years.

The dairy farm sector is recorded in other surveys as achieving lower productivity growth that the sheep and horticulture sectors in the 1980s (Philpott 1994). These results suggest expanding production is accompanied by productivity gains and that continued investment in the industry has been a problem over a considerable period in the past. It is thus clear from the results of this analysis that a greater focus on increased production techniques and performance will be required to meet the McKinsey growth objective in the dairy farm industry in the future.

Technical Appendix

1. Terminological differences

In a number of reports total productivity is referred to as total factor productivity (ABARE 2001; Forbes and Johnson 2000). In strict terms, total factor productivity relates to the ratio of value added to factor inputs alone. In this paper, productivity relates to a whole farm approach as does the ABARE report on the Australian dairy industry and is called total productivity throughout.

2. Index numbers

To overcome the base year bias problem in volume indexes (and price indexes), the Tornqvist discrete approximation to a Divisia Index is utilised. This defines the output index, O_t, as the weighted change in the proportions of its base weighted and current weighted components:

(1) $$O_t = \Sigma_i (O_{ti} / O_{oi})^{1/2 (w_{ti} + w_{oi})}$$

where w_{ti} = the share of the ith output (j^{th} input) in total nominal output (input) in year t, and

w_{oi} = the share of the ith output (j^{th} input) in total nominal output (input) in the base year.

This can be transformed by logarithms to the base e to give the estimation formula:

(2) $$\ln O_t = \Sigma_i 1/2 (w_{ti} + w_{oi}) (\ln O_{ti} - \ln O_{oi})$$

By taking anti-logs, the base year takes on a value of unity. The resulting index numbers now represent a moving weighted geometric average of base year output quantities and the current output quantities.

For comparative purposes, index numbers for total input and total output are also estimated on a base set of weights and a current set of weights.

(i) Base year weighting: relative importance of components to some chosen base year, o:

(3) $$O^*_t = \Sigma_i (W_{oi} O_{ti}) / \Sigma_i (W_{oi} O_{oi}),$$ i outputs; (Laspeyre index)

W_{oi} = weight in year o for i^{th} output.

This reads as current level of output at base year weights compared with base year output at base year weights.

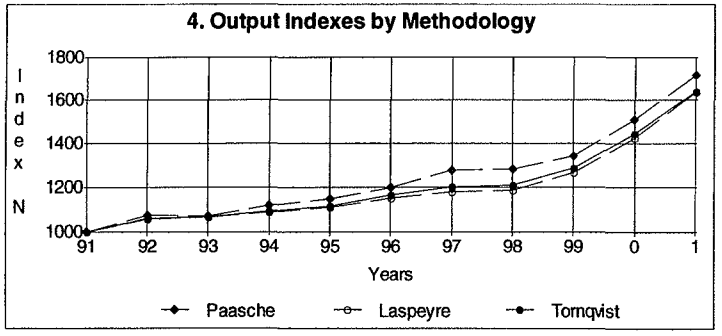
(ii) Current year weighting: weights reflecting current importance, base year quantities

(4) $$O^{**}_t = \Sigma_i (W_{ti} O_{ti}) / \Sigma_i (W_{ti} O_{oi});$$ (Paasche index)

W_{ti} = weight in year t for i^{th} output.

This reads as current level of output at current weights compared with base year output at current weights.

The Fisher Ideal Index is the geometric average of the Laspeyre and Paasche indexes. The Tornqvist index gives a close approximation to the Fisher Ideal Index as in Chart 4. As milk income dominates dairy farm output, the different index number methodologies give fairly similar results.



3. Growth Formula

Change in productivity and its components can be shown as annual percentage changes, average percentage change over a period, and by means of charts. The average percentage change formula is:

(5) $$\ln O_t = a + bT$$

where O_t = weighted index number of output etc
a = a constant
b = regression coefficient, and
T = years

If the estimated regression coefficient is 1.033, this reads as $ln\ O_t$ increases by a multiplicand of 1.033 per year, or 3.3% additional per year. By measurement in logarithms, the same percentage change applies to every year.

4. Measuring the stock of "Capital"

In productivity analysis, Capital represents the fixed assets used in the production process. Economists like to distinguish between capital goods which last over a period of years and current goods that are used up in the short term production process. This convention invades all accountancy terms of measurement and leads to the concept of depreciation as a justifiable tax allowance. Thus in accountancy asset values are distinguished from "cash expenses".

So when economists want to measure productivity they need to have a measure of "capital". Conceptually, capital should measure the volume of lasting goods which contribute to ongoing production. The way to measure this is to work out how much has been spent on such capital goods at any given time and then estimate by how much it has lost effectiveness through wastage. Such wastage could be called true depreciation (to be distinguished from tax-allowed depreciation). The data needed to measure such a physical inventory of goods consists of all past spending on such capital goods and some idea of the rate at which they waste or decay. The best way of measuring this is to have periodic inventories carried out and to ascertain what has gone missing.

Market values of assets on a balance sheet do not meet these requirements. Market values measure what valuers think the assets are worth in the market place. This in turn depends on what owners or potential purchasers think such assets can produce in the future. In this study, market value is deflated by an index of land (and buildings) prices estimated by Quotable Value New Zealand. Equipment and livestock values in the balance sheets were deflated by Statistics New Zealand indexes of the prices of the relevant goods for dairy farms.

Owner operators have a large proportion of their capital locked up in land and buildings. Sharemilkers, on the other hand, have no land capital but relatively high investment in equipment and their herds.

5. Livestock sales

The survey accounts treat livestock sales as a "net" sales figure, by deducting annual purchases of replacement stock. In the 50/50 sharemilkers sample purchases exceed sales in some years. In this case the total output and total input variables have to be redefined on a "gross" basis. This makes a difference to the productivity estimation for the years concerned but does not affect the analysis presented here for the years 1990-2001.

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IS THE NEW ZEALAND DAIRY INDUSTRY WALKING A TREADMILL?

Paper contributed to conference of NZ Agriculture and Resource Economics Society, Blenheim, 5/6 July 2002

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Abstract
The paper states the two forms of the treadmill hypothesis and seeks to establish whether the NZ Dairy Industry has been working on a treadmill of rising productivity and falling real prices, so that real incomes have failed to increase over the period 1950-2001. When a treadmill is being worked one would expect increases in the scale of farming and a steady flow of technical innovations designed to increase productivity per animal and per hectare. The data examined for the period 1950-2001 are such that the treadmill hypothesis cannot be rejected. This raises the question whether Fonterra Co-Operative Group will be able to make a clean break with the past and put the industry on a new footing of rising productivity and rising real incomes per hectare and animal employed. What are the policy implications of a possible failure?

Key Words: dairying, treadmill, rhizoids, productivity.

Introduction
This paper seeks to examine the treadmill hypothesis in terms of the development of the New Zealand dairy industry over the past half century. Although the history of this industry is a very rich one, a complete history of the past 50 years would go far beyond the scope of this study.

The Treadmill Hypothesis
The treadmill hypothesis is based upon the fact that a large number of farmers sell their products to a large world market, without co-ordinating their production plans. They are price-takers. As a result of their production system involving a very high element of fixed factors such as land, labour (often provided by family and some hands) and machinery, a fall in prices received would not cause them to reduce their production. On the contrary, they would try to increase their production in the face of a lower price in order to maintain their income. Any increase in productivity would strengthen this tendency.

Since demand for food, generally, increases slowly, mostly on account of a growth in population and incomes, there is a tendency for supply to grow somewhat more rapidly than demand, resulting in falling prices and incomes, given volumes. Thus, the price elasticity of supply is very low and even lower than the (low) price elasticity of demand. Faced with a fall in income, farmers increase productivity and output, resulting in lower unit costs, and hope thereby to increase their income to at least the previous level. In reality, the price falls yet again, providing farmers, therefore, with another incentive to raise productivity.[2] Of course, where possible farmers substitute higher priced crops or production for lower priced, where possible. Thus, sheep-and beef-farmers have been converting to dairying during the 1990s. However, the tendency of supply to outstrip the growth in demand may also apply to the higher priced production.

[1] I thank my colleague John Lepper for a critical review of a first draft. Ant remaining errors are my own responsibility.
[2] See W.W. Wilcox and W.W.Cochrane, Economics of American Agriculture, Englewood Cliffs, 1960, pp.469-476 and

Farmers are unable to lower production when prices fall also because their input-mix is determined by their choice of production. In agriculture there is no continuous degressively rising partial production function, because the means of production are complementary to the output-mix. Once a farmer has decided to grow grass for a herd of cows he is bound to use a certain quantity of fertilisers and silage and will have to consult the vet when the cows fall sick.[3]

The case for an increase in production and in productivity, consequent upon a fall in the price received, can be made both for given technology and for the introduction of new technology. Under the former, farmers will increase production by, for instance, putting more cows on their land or by bringing a piece of marginal land into production. Under the latter productivity is likely to rise more rapidly, so that output might increase more rapidly, also when prices are stable or rising. J. de Hoogh and H.J. Silvis argue that the major increase in the productivity of agriculture in Western Europe after the Second World War was due to the mechanisation and automation of production as well as bio-technical innovations. Given the substitution of machinery for human labour, many farms had insufficient land to employ the new machines. To compensate for the lack of land, farmers had an incentive to use more productive plants, weed-killers, fertilisers, water-control systems and disease-control. From this point of view, agricultural policies to stabilise prices and incomes are a derivative of general technical/economic developments. The authors do not deny that such policies too would have had the effect of increasing productivity.[4] Dale E. Hathaway throws more light on this subject by drawing attention to the fixity of assets deployed in agriculture. Following Glenn L. Johnson he argues that the salvage value of most assets used in agriculture lies below the costs of acquisition, whilst the value in agricultural use will be above the salvage value outside of the industry.[5] Hence, once acquired, assets tend to remain in agriculture. Hathaway applies this analysis also to farm labour. The cost of acquisition is the income a farmer could earn in an occupation elsewhere. It will be well above what he earns in agriculture. The salvage costs is what he could earn elsewhere once employed in agriculture. The older the farmer the lower the salvage value.

For a large block of land the cost of development such that it could be used profitably for manufacturing or services would be very high indeed. It is, therefore, left in agriculture. The salvage value of smaller parts of the land, however, could be very high, tempting the farmer to sell them off to the highest bidder. Similarly, he or she might expect to reap a large salvage value of the land on retirement, especially when the value of land is pushed up under conditions of inflation. In other words, the train of logic runs opposite to that of other assets. Nevertheless, it explains why large tracts of land remain in agricultural production.

[3] J. de Hoogh and H.J. Silvis, EU-Landbouwpolitiek van binnen en van buiten, Wageningen Pers, 1998, page 6.
[4] J. de Hoogh and H.J. Silvis, ibid., pp. 5-9.
[5] Dale E. Hathaway, Government and Agriculture; Public Policy in a democratic Society, MacMillan, New York, 1963, pp. 110-125.

The general picture is that of agriculture as a trap for assets. Farmers have every incentive to acquire the latest technically advanced assets and once they have them they squeeze out of them every ounce of productivity they are capable of. Clearly, this provides the producers of such assets with an incentive to sell as many as possible of such assets to farmers. The on-going pressure on farmers to lower costs by initiating larger scale and more intensive production processes makes them captive to a technicistic and economistic society. The demands of technical progress and the profit motive tempt them to treat their animals and pastures as if they were mechanical instruments designed to maximise income and profit. Output becomes much more important than animals and inputs.[6]

Another inference of the treadmill theory is that when farmers operate under a guaranteed output price scheme, they will have an even greater incentive to increase their production and productivity. Such schemes appear to allow relief from the drudgery of moving on a treadmill.

Historic Background: the 1930s
After the introduction of refrigeration the NZ dairy industry developed very rapidly as it found a ready outlet for its products on the UK market. Prices tended to rise.

As the industry became organised, partly through the efforts of the Ministry of Agriculture and, partly, as farmers felt a need to defend their interests, systematic efforts were made to improve production and quality. Herd-testing, for example, began in 1910.

During the First World War, the UK commandeered the production of NZ butter and cheese at fixed rather high prices. After 1922, however, when peace had returned and European production came on stream again, export prices began to fall. Both under rising and declining prices, production tended to increase. In the former case to benefit from improving fortunes and in the latter to defend one's income, especially if a high level of debt had to be financed, as Wiiliams notes.[7] He points out that when export prices rise, costs tend to remain unchanged, so that profits increase. No doubt, that is true under a fixed exchange rate regime. Profits decline, however, when export prices fall in this situation. Farmers who had incurred debt in good times would face financial problems.

[6] E. Schuurman has analysed the motivation, behaviour and outcomes of a technicistic society in a large number of publications over the past 30 years. His latest statement is: "Bevrijding van het Technische Wereldbeeld; Uitdaging tot een andere Ethiek" (Liberation from the Technical World View: challenge to a different ethics, PS), Technical University Delft, 2002.
[7] D.O. Williams, General Survey of Markets and Price Movements, Chapter XXVIII, in Agricultural Organization in New Zealand, H. Belshaw et al., Melbourne University Press, Melbourne, 1936, pp. 620-622.

This was certainly the case when the Great Depression broke out. As various countries that used to buy New Zealand dairy products, such as the USA and Canada, imposed tariffs or closed their borders, the UK market was flooded and prices declined precipitately. In 1932 the UK convened a conference to deal with the problem. This led to the Ottawa Agreement under which countries that were part of the British Empire obtained preferential access to the British market, for example in the form of lower import tariffs. The New Zealand dairy industry was afforded special treatment inasmuch as it was not made subject to a tariff on the UK market during the three-year period 1932-1935. In 1934, however, the UK changed its policy by deciding that UK farmers would get a guaranteed return on milk used for manufacture-particularly for cheese production. As a result of this policy some types of English cheese were sold at a lower price than that of New Zealand cheese.[8]

The industry decided to take stock of the situation. A Royal Commission of Inquiry was appointed. Its report became available in 1934 and made many recommendations to improve the quality of product and the efficiency and hygiene of production. As these were put into effect, foundations were laid for the future development of the industry.

At the time the Royal Commission was busy making its inquiries, the industry had the following characteristics:

a) 213 butter factories.
b) 275 cheese factories.
c) 56 dual plants
d) 56,819 suppliers of butter.
e) 12,803 suppliers of cheese and dual plants.
f) 69,622 suppliers in total, with an average number of cows in milk of 23.9.
g) Cows produced on average 104.420 kg. butterfat at the pail.
h) 435 were co-operatives. The New Zealand Co-Operative Dairy Company was by far the largest (perhaps also in the world).
i) 99.9 % of cheese produced and 99% of butter went to the UK.[9]
j) The average pay-out for butterfat was 8.75 pence per lb. for butter and 9.75 pence per lb. for cheese.[10]
k) Since 1925 New Zealand dairy produce was marketed under the Fernleaf brand. The Anchor brand for butter was also used, however.
l) 25,178 milking machines (17 makes, of which only one was imported) and 55,625 separators were in use on farms.
m) In view of the rapid decline in prices, many farmers had problems in servicing their mortgages. Under the Mortgagors' and Tenants' Relief Legislation, lenders were able to obtain relief in the form of extensions to terms, reduced interest rates, capitalisation of arrears etc. Many co-operatives provided finance to their suppliers.
n) There were seven species of purebred cows: Jersey, Friesian, Ayrshire, Milking Shorthorn, Red Poll, Guernsey and Shorthorn; the latter three were very small in number, however.[11]

[8] "Farming During the World Crisis", editorial in Belshaw et al., op. cit., page 801.
[9] F.B. Stephens, "The Processing and Marketing of Dairy Produce", pp. 648-689 in Belshaw et.al, op. cit. I have not been able to discover the reason for the discrepancies between the numbers of dairy factories in this text.
[10] Some data, especially regarding prices and productivity are taken from the statistical tables in A.H. Ward, A Command of Co-Operatives, The New Zealand Dairy Board, Wellington, 1975.
[11] H.G. Philpott, A History of the New Zealand Dairy Industry 1840-1935, Government Printer, Wellington, 1937, page 367.

During the Great Depression dairying was regarded as an easy way to earn an income. Most of the 70,000 odd farmers were very small, even by the standards of the times. They included people who had lost jobs in the urban economy, but who had some land on which they could run one or two cows and sheep and beef farmers who decided to have some cows to supplement their income. The former were affectionately known as "billycan" suppliers.

The reaction to the problems of the crisis were summarised by the head of the Department of Agriculture, E. J. Fawcett, as follows:

"The rapid and acute drop in the prices of dairy produce during the latter end of the 1929-30 season, and its continuance, has placed an entirely different complexion on the industry. Undoubtedly, the normal expenditure on maintenance has been temporarily restricted, but a Dominion-wide recognition of the fact that the surest and most economic method of reducing costs is to increase per acre production, has resulted in a rapid increase in total output. It is as yet too early to foresee the outcome of a lowered price level, but the country's dependence on the dairy industry to meet a large percentage of the interest on its external debt is fully recognised."[12]

In a sense this statement suggests that the author was unaware of the dynamics of a treadmill effect which this reaction to the crisis could bring about.

Anyhow, the First Labour Government (1936-1939) decided to introduce a guaranteed price scheme for New Zealand dairy farmers. Under this scheme the Government guaranteed a price at the beginning of each season. The Dairy Board compulsorily acquired export produce and banked the receipts into an industry reserve account from which the farmers were paid. With various permutations it remained in force until its abolition in 1985/86. Until its abolition overdrafts on this account were charged at an interest rate of 1% p.a.

In the period following the Depression and the Second World War (effectively ended for the industry in 1948 when the UK supply agreement was terminated) the industry would continue to wrestle with questions of market access, especially to the UK market and market stabilisation.

The Period 1950-2000

Around 1950, the number of suppliers had declined to 53,000. Most of them belonged to co-operatives. However, a large number, about 14,000, were townmilk suppliers. In those days the meat and wool industries were considered to be far more important than the dairy industry as earners of foreign exchange. It was the time of the Korean War and the associated wool boom.

For many years the meat industry was the chief pastoral industry, certainly in terms of export earnings and employment. Many dairy farms were converted to sheep and beef farms. During the early 1970s some agricultural experts doubted whether the dairy industry had much of a future.

Towards the end of the 1990s, however, the dairy industry was in the midst of a strong expansion, whereas wool had become a by-product of the meat industry and the size of the sheep and beef industry was shrinking rather than increasing. Many farmers had developed forestry on their farms or had sold out to forestry developers. Most pastoral

[12] E.J. Fawcett, Dairy Farming, page 471 in Belshaw et al., op. cit.

farmers had to supplement their incomes from other pastoral farming with incomes from other jobs, including farm tourism.

Since 1950 seven key events have had a bearing on the international development of the dairy industry. These were:

1. The end of duty-free entry of dairy products into the UK and the introduction of quotas from 1961 onward.
2. The start of the Common Agricultural Policy (CAP) in the six EEC countries in 1962.
3. The entry of the UK into the European Economic Community in 1973. New Zealand negotiated a set of quotas of dairy produce that could be exported to the EEC (butter, cheese). The UK had foreshadowed this decision in 1964.
4. The implementation of a production quota system by the European Economic Community in 1984, designed to limit the annual production of milk.
5. Also in 1984 the New Zealand Government (Labour) started to remove all Government support for farmers.
6. The fall of the Iron Curtain in 1989 and the subsequent negotiations by former East Bloc countries to become members of the European Union. East Germany, an important dairy producer, became part of the EU through its merger with Western Germany.
7. The Uruguay Round, which included agriculture, and which ended in 1994, followed by the establishment of the WTO in 1995.

Each of these events has been a challenge to the New Zealand dairy industry. It has responded by improving its productivity, diversifying its exports and taking stakes in a wide variety of dairy industries overseas through the NZ Dairy Board. As a result of the Board's efforts New Zealand has become the largest international trader in dairy products. At one stage, it sold the EU's butterberg to the Soviet Union, which paid in part by a supply of Lada motor cars.

Within New Zealand the industry has been subject to constant technical change. A few of the major developments may be referred to.

It was around 1950 that the Artificial Breeding (AB) programme began. At the same time the mechanisation of farming led to the collection of milk from the farms by tankers, so that the widespread use of cream separators on farms came to an end. For much the same reason hand-stripping disappeared. Tractors became steadily more versatile and farmer-friendly (in 1948 Ferguson introduced the 3-point linkage). To handle cows on the farm a motorised backing gate became an essential tool along with trailers, mowers, grass harrows, spray pumps and booms, the high-pressure water hosing system and motor-bikes.

Under the guidance of Dr. C.P. McMeekan, who had became the head of the Ruakura research station in 1943, the milking process was closely studied. During the 1960s Mr. D. Phillips built a new type of milking machine that relied on a system of pneumatic pulsators, running on a vacuum. By providing differences in pulsation, the system was kind to cows and cups could be gently squeezed. Milking sheds that used this new machine did not have to be equipped with drive gear. Patents were registered for the various innovations of this machine. The national Dairy Association in Hawera was to manufacture the machine under license. However, traders of milking machines strongly objected that only one organisation could produce this machine. The Government agreed and made the patents public. As a result New Zealand could not benefit from this

invention, which had put it far ahead of the rest of the world. Subsequent generations of milking machines everywhere now feature these innovations.[13]

Milking sheds evolved from the walk-through model to the herringbone sheds during the 1970s and 1980s and rotary platform (1980s/1990s).

The rapid development of aircraft during ands after the Second World War led to the widespread introduction of aerial top-dressing of pastures with phosphate fertilisers during the 1950s.

Cows were, of course, not forgotten. From the review of the 1930s above it is clear that New Zealand had only a limited number of dairy breeds. In the 1960s the Government decided to bring in new cattle strains, preferably from outside the British gene pool.[14] However, this appears to have had a greater impact on the beef than on the dairy industry. The latter saw the introduction of Holstein cattle, crossed frequently with Friesians. Jerseys and Holstein-Friesians are by far the dominating breeds today.

P.W. Smallfield has drawn attention to the importance of research:

"Probably the greatest contribution to farming in the 1950s was the development of large and efficient research stations dealing with practically all problems of primary production; the Departments of Agriculture and Scientific and Industrial Research, Massey and Lincoln agricultural colleges and the dairy, meat and wool research institutes all made important contributions."[15]

Smallfield refers in this connection also to the increasing use of chemicals since the 1950s. In 1959 the Agricultural Chemicals Act was passed. It set up the Agricultural Chemicals Board to register and control the labelling and use of agricultural chemicals.[16]

In terms of processing automation, the development of milk-powders and increasing sophistication in extracting more elements from milk for the production of ingredients, functional food and pharmaceutical products should be mentioned. Today's processing plants have considerably greater capacity than those of the early 1950s and are much more large-scale. Some of the world's largest cheese and milkpowder factories are located in New Zealand. It is significant that under the Dairy Board's control, companies tried to improve their pay-out by moving to larger scale processing units so as to reduce their unit costs below the industry average. One reason for this was that the Board determined its pay-out on the basis of average costs of production of all co-operatives. This triggered, therefore, a treadmill effect.

The Dairy Rhizoid

Throughout the period under review the dairy industry remained a very cohesive and distinct rhizoid under the guidance of the NZ Dairy Board and the dairy co-operatives.

[13] I am indebted to Mr. D. Philips for this information about the Ruakura milking machine.
[14] G. McLauchlan, The Farming of New Zealand, Australia and New Zealand Book Company, Auckland, 1981, page 218.
[15] P.W. Smallfield, The Grassland Revolution in New Zealand, Hodder &Stoughton, Auckland, 1970, page 129.
[16] Ibid., page 130.

A rhizoid is defined as a combination of inter-personal relationships designed to run one or more transformations of things such as grass into milk and milk into a variety of dairy products. Stows and flows and the interactions between them are at the heart of rhizoid theory. For example, a flow of grass is transformed through the stow of cows into flows of milk, methane gas and cow pats. Flows of milk and dairy products are to be sold for profit and, thus, result in a return flow of money back to the initial producers and their suppliers. The right husbandry of stows and flows is of vital importance for the long-term sustainable development of a rhizoid.[17]

Recently, the importance of the gene-pool of cows has been stressed as a factor in long-term sustainability.[18] In terms of rhizoid theory this is a crucial stow. Over many years the rich diversity of the gene-pool has been reduced as a result of Artificial Insemination (AI) and the systematic selection of traits able to increase production of milk and meat. Indeed, the number of distinct breeds of cows has been falling around the world.

In order to achieve and improve the transformations and flows, farmers will relate to many service providers such as:

a. veterinarians;
b. soil scientists;
c. grassland experts;
d. herd testers;
e. accountants;
f. bankers;
g. directors and staff of dairy co-operatives;
h. Government officials
i. mechanics to repair machinery;
j. suppliers of tractors, harrows and other farm implements and of seed, medicines etc;
k. auctioneers;
l. sheep and beef-farmers;
m. growers of maize, lucerne;
n. share-milkers;
o. neighbours;
p. and media.

One should not underestimate the number of suppliers to dairy farmers. The June issue of the "Dairyman" listed 132 suppliers of a wide range of goods and services. This is by no means an exhaustive enumeration. Given that the industry has been doing relatively well, it has attracted the attention of many business people keen to make some money by supplying dairy farmers. If it were possible to trace the flow of money from overseas via Fonterra to the farmers and from them to the suppliers it would be possible to estimate the total number of hours required to produce the output of the industry. Another way of putting it is that as farms become more large-scale, the dwindling number of farmers is serviced by a growing number of providers of goods and services required to keep the farmers going. To what extent this makes for a more efficient or a less efficient industry is a matter of empirical analysis.

[17] An initial outline of rhizoid theory is: John Lepper and Petrus Simons, Systems of Economic Relationships; Three Essays on Rhizoids and Their Applications to Social Science, Integrated Economic Services Ltd., 1996.
[18] For example, Rene Passet, L'Economique et Le Vivant, 2nd edition, Economica, 1996, page 79.

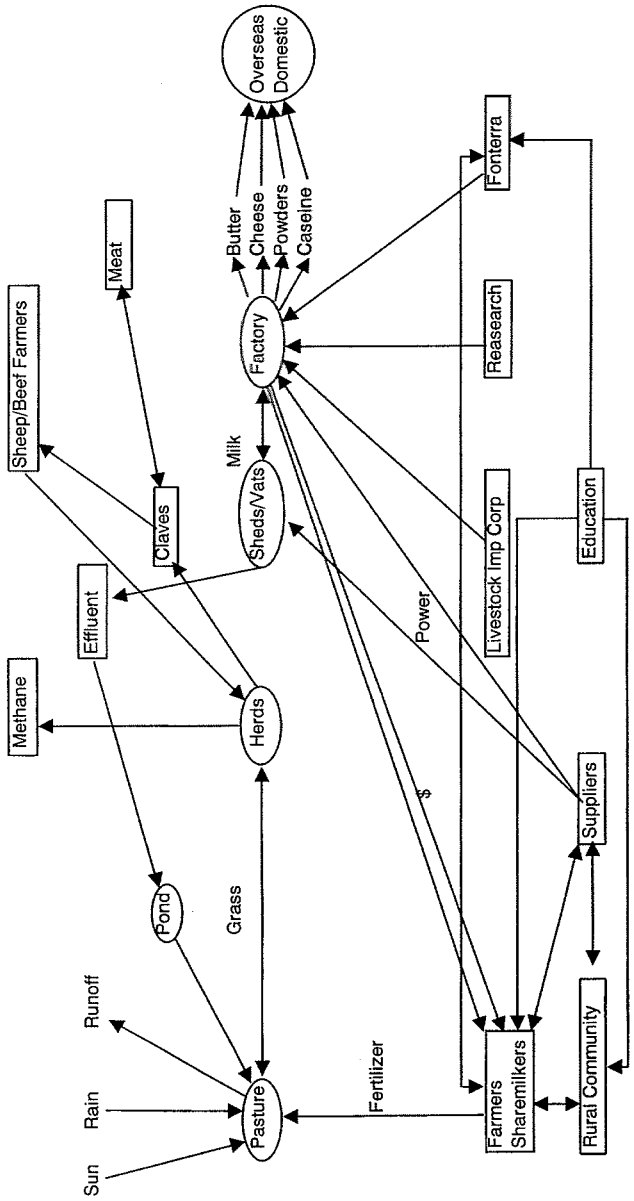

Figure 1 sets out a diagram of the dairy rhizoid.

NZ Dairy Rhizoid

The dairy rhizoid in New Zealand has become a very cohesive one especially since the end of the First World War and the Great Depression. Since it has had to export to survive its cohesiveness has allowed it to learn quickly and to adopt and develop the latest dairy technologies. Challenges such as the growing export surpluses on world markets since the establishment of the European Union and its predecessors, have put a premium on innovation and clever marketing. In the process the rhizoid has been changing very significantly, from small-scale to large scale.

Thus, the number of dairy co-ops declined from about 250 in 1950 to 4 at the end of 2000. In 2001 the two largest merged with the NZ Dairy Board to form Fonterra Co-Operative Group, with important stakes in the Australian dairy industry. Only two small co-operative companies: Tatua (Waikato) and Westland Dairy Co-operative (with a supply arrangement for Tatua) remained as independents.

It is a peculiar characteristic of the New Zealand dairy industry that it exports about 90% of its annual production. It is the only country with such a high ratio of exports. World-wide only 5% of dairy production is internationally traded. Since the New Zealand industry controls, through the NZ Dairy Board, about 25%-30% of this trade, it is by far the largest international trader of dairy produce. It should be emphasised, however, that this trading position has evolved from the unique position New Zealand has had since the late 1880s as a key supplier of dairy produce (especially butter and cheese) to the United Kingdom.

A Rhizoid Approach to Productivity

The various elements of the dairy rhizoid influence farmers' decisions with regard to the management of pastures, herds, milking and processing. Actions by neighbouring farmers and contacts at ward conferences and field days would also have a bearing upon a farmer's decisions.

The concept of a neo-classical production function governing how various doses of labour and capital inputs would result in output, given technology, cannot be used to account for productivity developments in the dairy industry, if a rhizoid approach is taken. There is no single decision-maker to decide how much labour and how much capital should be combined to achieve a certain output, given a production technology. As pointed out above the production process is spread out over a wide range of farmers, suppliers and processors. They have been inter-connected via the co-operatives and the NZ Dairy Board. Moreover, flows that tend to damage the environment such as methane gas and fertiliser run-off should be accounted for as costs.

All the elements of the rhizoid may have a bearing on the efficiency of the various transformations such as the conversion of fertilisers into grass, grass and water into milk, milk into cheese, butter and other dairy products. Veterinary science might discover a way of accelerating the fermentation process in a cow, for instance. A manufacturer may invent a better milking shed or milking machine. One invention or improvement may have consequential effects in other parts of the rhizoid, to the effect of compounding the initial effect on productivity. The Government could put more or less money into combatting tuberculosis by the eradication of opossums. In short, there is no systematic approach to innovation or to improving productivity in the rhizoid. There is even a possibility that some actors are not interested in improving their efficiency. A supplier of hoses, for instance, might enjoy a local monopoly and charge a high price for the product, albeit at the risk of being supplanted by a larger scale nation-wide manufacturer and distributor. Until this happens his local standing in the community may be so high that farmers accept his high price.

Over almost any period of time technical change in the dairy rhizoid occurs both in terms of new applications of existing technology as well as new inventions. New developments have a largely random character.

If we use a rhizoid approach, then, we must concentrate the measurement of productivity on key transformations. The reason is that transformations are set up to yield higher value flows. In the dairy rhizoid the key transformations are those of grass and other elements into milk by stows of cows, represented by butterfat or Milk Solids (MS) and the transformation of milk into dairy products. Since the latter is dependent on the former, it appears that the cow should be the unit for the measurement of productivity. A subsidiary measurement might be the production of MS per hectare of pasture. Indeed, the cow is at the receiving end of advances in scientific knowledge, technical developments, changes in management practices and so on. The effectiveness of the wide range of supplies as purchased and used by farmers must be shown in the output of MS per cow and per effective hectare.

Another way of approaching this is to imagine that the whole rhizoid came to a complete standstill one day. How would it be re-started? In some way the whole stow of technical blueprints, scientific and technical knowledge, practical skills of farmers and share-milkers would have to be pressed into action once flows of sunshine, water and grass appeared again and new herds could be formed. The quantity of milk produced per cow and per effective hectare would then reflect the success or otherwise of the combined effort of the rhizoid. Without grass, cows and milk there would not be a dairy rhizoid. All this assumes that there is a suitable price for milk produced. The effectiveness of the production and marketing processes of the dairy companies has a particular bearing upon this price. When the price per kg MS is multiplied by the output per cow, a gross measurement of productivity in money terms is obtained. Given data limitations we cannot determine net productivity, i.e. by subtracting all costs incurred by the rhizoid to produce a kg MS. Although each individual farmer is able to do this quite readily, the sum of all these costs does not adequately measure all costs of all suppliers incurred, for example, to keep labour and capital available even when it is not fully utilised. Nor are the flows measured that are not expressed in money terms such as discharges of effluent into waterways. A large increase in the output of MS per cow, given price, accompanied by severe environmental degradation, may not be sustainable and should, therefore, be discounted.

If a large increase in output per cow is brought about by means of large purchases of supplies and power supplied by a variety of local monopolists, the farmer may be unable to put aside sufficient reserves to finance any expansion. Most of the profits would be enjoyed by other rhizoid participants, who may spend them on consumption. Something similar may occur in the processing transformation, if, for instance, the executives of the plant enrich themselves at the expense of the farmers or put aside such a large part of the money flow into their establishments that the farmers are unable to finance any improvement in their productivity. Expensive new processing plant would then have to process poor quality milk.

In general terms productivity may be defined as the economic measurement of a technical production process.[19] The rhizoid knows how to produce milk from pastures and herds of cows in a technical sense. There is no systematic effort undertaken, however, to measure the economic outcome of the technics deployed in any comprehensive sense.

[19] I am indebted to H.van Riessen, philosopher of technology, for this definition. (Christelijke Encyclopedie, J.H. Kok, Kampen, 1960, Vol. V page 512).

In rhizoid theory there are no factors of production such as labour, capital and land. Those working apply their stows of knowledge to transform stows of milk (inside cows' udders), for instance, into flows of milk (i.e. by milking a cow either by hand or by means of a machine). Similarly, capital is composed of stows such as technical/scientific knowledge and practical knowledge of farmers and is embodied in a wide variety of machinery and laboratories on and off the farm.

In the neo-classical model of measuring productivity, pastures, herds and farm machinery would have to be treated as capital and farmers, sharemilkers and farm hands as labour. This is a far too limiting approach, inasmuch as it seeks to link a limited number of flows to a flow called output, without knowing much at all about what happens in the intervening transformations. Many important flows such as those contributed by suppliers and negative flows that diminish the ability of the environment to yield useful flows are ignored.

Testing the Treadmill Hypothesis

Our first task is to examine the data over the period 1950 to 2000 to find out whether it is consistent with the treadmill hypothesis. To do this I have calculated the annual change in the ratio of MS processed per cow, using the herd statistics of the NZ Livestock Corporation. I then have multiplied this change in productivity by the annual change in the pay-out price, adjusted for inflation, received by suppliers of dairy co-operatives from their co-operatives. These include the cows of herds allocated to town-milk supply. I have assumed that milk supplied for towns (local consumption) is priced in sympathy with the pay-out received by members of dairy co-operatives. Industry representatives believe that this is a fair assumption. In order to remove seasonal factors, the annual changes are based upon 5 year moving averages.

Table 1 sets out the productivity per cow in terms of milkfat processed.

TABLE 1
INDICATORS NZ DAIRY INDUSTRY 1950-2000

PERIODS	COMPOUND ANNUAL GROWTH%		
	MILKFAT PER COW	REAL PAY-OUT	NUMBER OF COWS
1950-1960	+1.27	-2.8	+0.20
1960-1970	-1.38	-3.3	+2.09
1970-1980	+2.94	-0.7	-1.27
1980-1990	-0.03	+0.5	+1.24
1990-2000	+1.16	-2.0	+3.52
1950-2000	+1.23	-1.6	+1.15
1950-1973	+0.29	-1.8	+0.74
1973-1984	+2.14	-1.5	+0.08
1984-2000	+0.43	-1.6	+2.48

Source: Livestock Corporation of New Zealand.

With the exception of the decade 1960-1970 productivity, expressed as milkfat processed per cow, has been increasing steadily. Over the whole half century ending in 1999/2000 it rose at a rate of +1.23% compound per annum. It is understood that the indicator has been affected not only by deliberate efforts to increase productivity but also by natural factors such as droughts and floods and TB in cattle. On the human side, processing and marketing efforts are likely to have contributed to this rise. The tendency towards larger herds, the introduction of new processing facilities such as rotary sheds, milk trucks and of the milk train from Hawkes Bay to Hawera in the 1990s may have played a role as well. In fact, the average size of herds increased from 35 in 1950 to 124 in 1980 and 236 in 2000. The industry, therefore, is now much more large scale than it was in 1950.

This state of affairs highlights the need to approach key developments in the dairy industry from a rhizoid point of view. From the perspective of the dairy industry, the steady rise in productivity of 1.23% compound p.a. over the past 50 years would be seen as a measure of success. However, once all costs of this development were taken into account, it might be considered in a more sober light.

In contrast to productivity, the real company pay-out price fell at a compound rate of –1.65% p.a. over the whole 50 year period and, consequently, overwhelmed the rise in productivity. In general, the rhizoid has reacted to this by increasing the number of cows and reducing the number of herds. The pay-out price reflects, of course, not only movements in the world price of dairy products but also domestic influences as captured by movements in the Consumers Price Index, the index used for deflation purposes. In turn, this index is influenced by monetary and fiscal policy. For example, from 1994-1997 the New Zealand Dollar appreciated against the currencies of its major trading partners. This had the effect of lowering the New Zealand Dollar value of export revenue expressed in foreign currency (mostly US Dollars). On the other hand it reduced the price of imported inputs such as oil products, fertilisers and farm implements.

Table 2 sets out the total pay-out received, adjusted for inflation, during the same periods as used in Table 1.

TABLE 2

TOTAL DAIRY PAY-OUT	ADJUSTED FOR INFLATION 1950-2000 (1999 CPI)
YEAR	$MILLION
1950	1,612
1960	1,409
1970	1,160
1973	1,430
1980	1,129
1984	1,406
1990	1,346
2000	1,860

Source: Livestock Improvement Corporation, Statistics New Zealand.

In the light of this table the concerns about the future of the industry around 1970 are understandable. Considering the whole period 1950-2000 and using the real pay-out of 1950 as a basis (index value 100) we can calculate for all years 1955-2000 a five year moving average index of real pay-out. Table 3 sets out the index values for a number of years.

Table 3
Index of Real Pay-Out (1999 Prices) 1950-2000 (1950=100)
Five Year Moving Averages

YEAR	INDEX
1960	92
1970	88
1980	69
1990	71
1991	66
1992	72
1993	78

1994	81
1995	83
1996	94
1997	98
1998	99
1999	100
2000	105

Tables 1-3 suggest that over a period of about 50 years the industry became large scale, and technologically advanced, with gross productivity increasing at a compound rate of +1.23% per annum and yet for most of the time receiving a total real income below the level enjoyed in the 1950s. Only during the second half of the 1990s was the level of the 1950s achieved again.

Especially during the second half of the 1990s the number of dairy co-operatives declined strongly as the two largest ones, New Zealand Dairy Group and Kiwi Dairies absorbed a number of smaller ones. Two co-ops, however, have declined to merge with the two largest ones. One of these is Tatua. It has always been a small co-operative, counting no more than 130 suppliers at present. Its game has been to produce high-value products based on the ingredients of milk, rather than milk powders, butter, cheese and casein. As a result it has consistently paid the highest price per kg of MS than other co-operatives. The second is Westland Dairy co-operative, situated on the West Coast of the South Island and a specialist cheese manufacturer. It produces products for Tatua.

Does the development of the past 6/7 years suggest that the industry has succeeded in increasing its scale, production and productivity at a rate that has been more rapid than the rate of price increase? If so, then the question is whether it may look forward to a future beyond the treadmill of the past? Would Fonterra Co-Operative Group be able to help secure such a future?

Before I attempt to answer this question, the treadmill hypothesis should be looked at from another angle.

If dairy farmers were faced with a treadmill effect on their income and, consequently, re-organised their farms from small scale units to much larger units, then, the values of farms should have reflected their expectation that thereby they would improve the capital value of farms over time.

Data of the average value of dairy farms sold on the open market, along with the average production of milkfat/milksolids, the average size in hectares and the value of the farm per kg of MS has been collected only since 1969. During this 31year period the average size of farm sold rose from 57 hectares in 1969 to 86 hectares in 2000 and average production of MS increased from 17,108 kg to 48,309 kg. Over the same period the sale price expressed per kg of MS increased from $2.13 in 1969 to $18.8 in 2000.

Since the Labour Government of 1984-1990 dismantled practically all Government support for agriculture during its term of office, so that "free trade" prevailed from 1986 onward, one might expect that productivity growth and the movement of farm values would show a clear difference between the periods 1969-1984 and 1984-2000. Table 4 shows the results.

Table 4
Comparison of Productivity Growth, Farm Values and CPI during 1969/84, 1984/00 and 1990/00

Periods	CPI	Farm Sale Price	MS per hectare	Average size
	1999=1000	Per kg MS produced		Hectares, Period Average
	Compound annual %	Compound Annual %	Compound Annual %	Hectare
1969/84	11.7	12.58	3.26	61.10
1984/00	4.9	2.54	0.88	73.81
1990/00	2.0	4.12	0.73	77.00

Source: Valuation New Zealand/Livestock Improvement Corporation and Statistics New Zealand.

It appears that the growth in productivity was very high during the first period of 1969-1984, when New Zealand agriculture was strongly supported by the Government in the form of subsidies for fertiliser and loans on favourable terms. In the mid-1970s floor prices for all major commodities were introduced. In 1978 a supplementary price scheme was put in place, on top of the stabilisation schemes, to supplement low prices, whilst the Producer Boards could still impose levies when prices were high. In addition, there were Government-run extension, inspection and research services.[20] These were all corporatised and/or privatised during the period 1984-1993. However, the most drastic measures were taken during 1985-1987 when the Supplementary Minimum Price scheme, subsidies and easy credit terms were abolished. The changes were so radical that the Government was forced to underwrite a debt relief programme in 1986/1987.

We should not jump to the conclusion, however, that these support measures were the sole factor for the high increase in productivity during 1969-1984. A steady stream of technical innovations also made a contribution.

Farmers have been able to see the value of their farms rising more quickly than the movement in the CPI, except for the period of economic restructuring 1984-1990. After 1990 farm values have resumed a trend of increasing real value. Thus, farmers leaving the industry can expect a compensation for their investment over the years.

The Treadmill Again

The changes in the institutional framework since 1984, from Government involvement to private control, has not ended the working of TATE, an acronym stands for Technical Administrative Task Environment and which has been dubbed by sociologist Benvenuti.[21] Under TATE individual farmers are directed by suppliers, processors, research institutions, farm extension services and Government regulations to implement new technologies and procedures aimed at maximising production.

Since the 1920s the New Zealand dairy industry has indeed been working under a TATE system. In 1924 the NZ Dairy Institute was set up to systematically research technical problems and improve the production of the industry on farm as well as in processing plants. Later on the Government sponsored research at Ruakura has played a key role. Of late, research has led to the production of cloned calves and bulls.

The establishment of the Livestock Corporation in 1948 by the NZ Dairy Board has given a strong impetus to a steady improvement of the genetic pool of the industry through

[20] Listed in R.W.M. Johnson, Reforming Farm Policy: Lessons from New Zealand, with a commentary by Richard Howarth, Institute of Economic Affairs, London, 2000.
[21] See Douwe Jan van der Ploeg, De Virtuele Boer, Wageningen, cyclostyled, 2000, page 436.

systematic herd testing and AI. All results of herd testing and the application of AI are recorded into a national database.

Since the rate of increase in the price of farmland per hectare is the product of the rates of increase in MS produced per hectare and in the price for the farm per kg of MS produced, Table 4 indicates that rising productivity, expressed as the increase in MS per hectare, has played a comparatively minor role in the movement of prices for farmland.

The faith of farmers in dairying as a more profitable way of farming than sheep or beef farming may be the reason for the increasing trend in farm prices, especially during the 1990s, compared with the rate of increase in the Consumers Price Index. A monetary policy, which relied on interest rates and left the money supply free, might have contributed to this strong rise in the price of dairy land. Such a rise in prices over and above the more general rate of inflation, allows farmers to retire with a capital gain free of tax.

R.W.M. Johnson draws the conclusion that the lesson from New Zealand is that when the market mechanism is allowed to allocate resources, farmers are able to stand on their own feet and that post 1984 life resumed its normal course. He underpins this observation by the following points:

1. Agricultural markets adjust by themselves and land values will find their appropriate levels.
2. Prices of land have returned to a normal relationship with product earnings.
3. The land market is less inflated due to market level charges for credit and the incorporation of risk into farm decision-making;
4. There is more flexibility between enterprises. There has been a decline in the production of sheep products and an expansion in cattle products, dairying and forestry.
5. The New Zealand reforms were unilateral. Research by the OECD shows that the benefits of agricultural policy liberalisation are maximised when countries deregulate multilaterally.[22]

If policy makers allow agricultural markets to adjust by themselves, then, they must also be willing to accept the consequences such as smaller rural populations and, possibly, environmental degradation. These are effects of the treadmill in operation. Johnson is right that the differences in the movements of land prices for dairy farms pre-and post 1984 have been comparatively minor. In other words the treadmill is working under both Government regulation and under a system of free markets. Table 4 suggests that the treadmill might actually go somewhat faster under regulation. However, this is not necessarily an argument in favour of a free market system. A judgement on this issue should be made not on the basis of dogmatism, but on the basis of a dispassionate analysis of what a country wants to do with its base of fertile agricultural land. Should it serve as a vehicle for a sustainable supply of food for the local population and for the longer-term development of regions and countries or should it be used as a means for earning foreign exchange to support the lifestyles of urban populations?

The Future

It is pleasing that the EU's pre-occupation with multi-functionality has shifted the focus of the debate towards these issues. As issues of animal welfare, organic farming and genetic modification are not yet a major part of this shift in focus, advocates of these matters will have occasion to push policy-makers even further along the path of multi-functionality.

[22] Op. cit., pages 37-40.

The formation of Fonterra Co-operative Group, with ambitious goals for expansion abroad, might shift the focus of decision-makers in the New Zealand dairy industry more in an opposite direction of larger economies of scale, more rural desertification and greater environmental degradation, especially as they have set themselves a goal of increasing productivity by +4% p.a. or +50% over ten years.

In May 2002 Dr Warren Parker has identified seven challenges that should be faced by the New Zealand dairy industry[23], namely:

1. Farmers need the capacity to respond rapidly to change (ageing of farm population and separation of management from farm operations).
2. The succession of farm leaders and farm owners (barrier of high fixed costs).
3. To intensify milk production in an environmentally-sustainable manner.
4. Improving returns per unit of milk.
5. A shortage of skilled labour and rising costs of labour.
6. Increasing energy usage.
7. The privatisation of intellectual property.

Absent from these challenges is a challenge of world markets flooded by subsidised exports from the USA and the EU. The pending accession of a number of Eastern European countries to the EU raises doubts as to whether such exports from that region will soon disappear. Many of these countries are traditional dairy producers. They are currently modernising their industries, partly by importing technical expertise in the form of Western European farmers migrating to Eastern Europe and Western co-operatives investing in new plant in those areas. The CAP framework will be extended to them, albeit in modified form. Thus, whilst Western European countries will reduce their production, the East will take over.

Underlying this trend is the fact that the dairy industry world-wide is subject to the same technical/economic imperatives. This implies that there is a treadmill at work in most countries that have a modern dairy industry. Fonterra Co-Operative Group's strategy appears to be to build up major stakes in the Australian dairy industry, so that it can effectively control around 40%-50% of world trade. This, in combination with investments in other countries should provide a flow of income even if world dairy prices fall because of subsidised exports.

The goal of 4% p.a. growth in productivity set for the industry provides a clear break with the past if it can be achieved. By paying more attention to the health and nutrition of animals part of this target can be achieved. However, it will also involve the introduction of automatic milking machines, cloning and genetic engineering. Such innovations are also likely to be made overseas. Since the costs of these innovations are high, the challenges posed by Dr. Parker might become even more urgent, especially if the rural areas continue to lose population and amenities.

As the current generation of dairy-farmers makes way for a new one, farms will become very large-scale and will be run, increasingly, as factories and operated under limited liability ownership. Cows are seen as machines that can be improved upon and replicated. As these farm factories are run for monetary profit, environmental regulations (Resource Management Act) and Kyoto Protocol are appreciated as interference by Greens.

[23] The Dairyman, June 2002, page 56.

If Fonterra were to fail to maintain a rising real total pay-out for the industry, then, there will be pressure for it to be taken over by a larger overseas organisation.

The only way to stop the treadmill is to move towards localised dairy industries around the world. Jacques Berthelot has proposed that all countries should be able to protect their local agricultural industries on the basis of import levies, provided that there is a strict prohibition of export subsidies in place.[24]

Conclusion

Indications are that a consistent increase in productivity has been occurring in the New Zealand dairy industry, but that it has been insufficient to overcome a downward move in the real pay-out price received by dairy suppliers, with the exception of the late 1990s. The strong expansion during the 1990s must, however, also be seen in the light of even stronger declines in the profitability of sheep and beef farming. The treadmill hypothesis cannot be rejected, therefore.

There is no guarantee that Fonterra will be able to stop the treadmill in the long run. A failure of Fonterra in this regard will raise the possibility that the industry will be taken over by overseas interests.

[24] Jacques Berthelot, L'Agriculture; talon d'Achille de la Mondialisation; Cles pour un Accord Agricole Solidaire a L'OMC, l'Harmattan, 2001.

Figure 1: Technology adoption happens quickly when:

The individual is	In a position in the farm system to access economic resources and make decisions.	Buttle & Newby (1980)
	Highly or 'better' educated.	Bultena & Hoiberg (1983); Lambur et al (1985); McGregor et al (1996)
	Receptive to new ideas (i.e. is innovative) and is a risk-taker.	Bultena & Hoiberg (1983)
	Younger and less experienced.	Ervin & Ervin (1982)
	Self-confident.	Bagozzi, Davis & Warshaw (1992)
The technology is	Easily integrated into existing farming and management operations (i.e. it is compatible).	Tornatzky & Kelin (1982); Culver & Seecharan (1986); Steffey (1995); Stantiall & Parker (1997)
	Going to help maximise profit for the farmer (i.e. it is economically advantageous) and the financial rewards of adoption will offset any increased difficulties or cost.	Pampel & van Es (1977); Cross et al (1995); Willock et al (1999)
	Simple (or not complex).	Herbert (1995).
	Going to offer clearly observable advantages for both the farmers and farm system.	Tornatzky & Kelin, (1982); Rogers (1983); Herbert (1995); Premkumar & Roberts (1999)
	New.	Rogers (1983)
	Perceived to be useful and easy to use.	Davis (1989)
	Congruent with the goals of the farmer and his or her values.	Willock et al (1999).
	Being adopted successfully by neighbours (i.e. it is spatially diffused).	Bala & Goyal (1998)
The farm system is	Large.	Lambur et al (1985)
	Linked to knowledge networks.	OECD (1997)
	Endowed with absorptive capacity.	Cohen & Levinthal (1990)
	Able to transfer information.	Nooteboom (1999)
	Profitable.	Byerlee & de Polanco (1986)
	Linked to other firms and networks.	Bala & Goyal (1998)
	Successful in terms of previous technology adoption.	O'Neill, Pouder & Buchholtz (1998)
	Able to unlearn non-innovative behaviours and break with traditional paradigms.	Nooteboom (1999)
The innovation system is	Linked or in contact with farmers (e.g. through extension services, field days etc.)	Steffey (1995); Harper et al cited in Herbert (1995)
	Significantly involved in management-intensive technology, but not as significantly involved for capital intensive technology.	Zepeda (1990)
Society is	Positive about, and accepting of, the technology.	Ison (1993)
The process is	Supported by extension activities that inform the farmer of the incentives of adopting the technology.	Wearing (1988); McNamara, (1991)
	Perceived to be low in risk.	Herbert (1985)
The input (information) is	Easily transferred between the source and the farmer, and promotes effective communication, problem identification and problem solving.	Contant (1990)
	Gained through personal interactions of a formal or informal nature.	OECD (1997)
	Not free (farmers are willing to pay for information if they believe the innovation will bring them an economic return).	Feder & Slade (1984)
	Not just fact based (e.g. computer based decision support systems are useful).	Hamilton et al (1991)
	Stimulating, provides contacts and facilitates collaboration.	Feather & Gregory (1994)
	Obtained from multiple sources.	Lambur et al (1985)
	Timely and available.	Wall et al (1985); Korsching & Hoban (1990); Premkumar & Roberts (1999)
	Perceived as credible (this is more critical the closer to the implementation stage the farmer gets in the adoption decision-making process).	Rogers (1983); Korsching & Hoban (1990)

Enabling technological learning in the New Zealand dairy industry

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ABSTRACT

The New Zealand Foundation for Research, Science and Technology has funded a project to examine the factors that impact on 'technological learning' (TL) in the on-farm sector of the New Zealand dairy industry (where TL refers to the process whereby farmers gather 'information' and turn it into 'knowledge' that can be used by them on their farms). Findings suggest that the speed with which farms engage in TL is influenced by the efficiency of the innovation system, the maturity of the farm system, and the individual characteristics of the farmer. A model is presented which demonstrates how congruence between these three factors impacts upon TL.

KEY WORDS

Technological learning, extension, dairy industry.

INTRODUCTION

A critical issue for industry bodies and governments is the need to encourage innovation and change amongst industry members in order to increase their levels of productivity, and enhance the industry's competitive position. In order to achieve this objective it is important that all those involved in making decisions that impact on productivity improvement and industry development (including the producers themselves) understand the complex processes and dynamics that are at work within and between organisations and individuals that are also involved in the context of the 'innovation system'.

The importance of individuals as key elements within the wider innovation system has been a theme of this project from its beginning, which in earlier phases has examined the particular contributions made by women (Hurley & Massey, 1999), Māori farmers (Kingi, Kuiper, & Clough, 2000), as well as the specific factors relating to small and large farms (Parker, Stantiall, Allen, Hurley, Kuiper, & Massey, 1998; Massey & Hurley, 2001). In this phase of the project the specific focus is on exploring the factors that impact upon the speed of 'technological learning' (TL), where this term refers to the way in which individuals gather information from research or other sources and turn it into useful knowledge.

"Useful' in this context can be defined narrowly, i.e. where technological learning actually equates with the adoption of technology. This approach has been the subject of a great deal of research, and the research team used the literature on technology adoption as the starting point for the current project. Figure 1 demonstrates how influences on the technology adoption process have been examined at a macro (i.e. societal and environmental) and micro (i.e. individual) level. In general terms, the table demonstrates the diversity of perceived influences on the adoption process. It also shows that there is an imbalance in current empirical work; there is far more examination of macro level influences. Clearly those influences that are controllable (and therefore measurable and/or observable) have received greater attention than those that are not or those that are more difficult to causally attribute.

This literature provides the context that led to the project's overall aim: to understand how to successfully engage individuals in technological learning (TL), both in the context of an industry and an enterprise.

Specific objectives of the project were to identify:

1. The ways in which institutional/industry structures, dynamics and inter-relationships contribute to technological learning in the on-farm sector of the dairy industry, in the context of productivity gains.
2. The competencies necessary for technological learning processes, innovation and productivity gain in the on-farm sector of the dairy industry.
3. The cognitive processes and heuristics which dairy farmers use to determine the acceptance and utilisation of new technological innovation.

METHOD

The research team's goal was to identify factors that impact on the speed with which farmers engage in technological learning. Building upon the literature and the previous phases of the project; where various aspects of TL were examined (including the role of the farm extension system), and combining qualitative and quantitative data collection (see for example, Hammersley, 1992), the researchers developed three inter-related research objectives and used four methods to gather data. These included an industry forum, interviews with industry members, case studies with farmers, and a questionnaire. These methods were designed to complement each other in terms of data collection, analysis and verification.

Forum

The one-day forum brought together farmers and invited industry representatives to discuss the issues facing the industry, particularly in relation to learning about technology. The primary purpose was to generate issues that could be developed further in the interviews, cases and the questionnaire.

Industry interviews

The interviews in the project sought to build on the understanding of issues identified in the literature and raised in the forum (i.e. the interviewees were not designed to be representative of a wider population). They were used to collect data from key informants in the dairy industry relating to their perceptions of the institutional activities, linkages and interactions, and generic technological learning competencies required of dairy farmers to achieve on-farm productivity gains. Interviewees were purposively selected after consultation with industry organisations and institutions identified in the workshop and the project's reference group. A semi-structured, focused approach was utilised and the interviews yielded in-depth opinions and perceptions. The interview schedule was devised specifically to ensure that interviewees were able to propose their own insights into on-farm productivity improvement in dairying, (i.e. findings from the forum were not shared with the interviewees at the beginning of the interview) and to enable the combined propositions from the workshop and the interviews to be used as the basis for further enquiry in the survey and the farm-level case studies.

Questionnaire

The questionnaire aimed to provide data that would allow some understanding of the psychological variables that affect technological learning. Questions focused on exploring the aspects of farming are important to farmers (to understand the decision-making context); identifying what practices have already been adopted (to gauge the extent to which technological learning has already occurred); and exploring the perceived relationship between stress and technological innovation. The questionnaire was based on the Technology Acceptance Model, which suggests that the use of new technology depends on two key beliefs: perceived usefulness and perceived ease of use (Davis, 1989). Questionnaires were distributed to 3000 farmers and responses were received from 998 (indicating a 33.2% response rate). As well as providing data for analysis in its own right the questionnaire data underpinned the case selection process, and the composition of comparison groups for the more intensive part of the study.

Case studies

Selection of the cases was based on theoretical replication, i.e. where the cases produce "contrasting results but for predictable reasons" (Yin, 1994, p 46), and the unit of analysis was the farmer. The cases were purposefully selected (from the farmers who volunteered via the questionnaire) to provide examples of farm size (based on herd size), rate of farm growth (initially gauged by farmer self-description) and the role of the farmer in terms of decision-making (i.e. owner/manager or sharemilker). The data enabled the researchers to describe the perspectives and the behaviours of the farmers concerned, and permitted a degree of cross case comparison (following Hammersley, 1992). In terms of data analysis a theoretical (as opposed to a descriptive) strategy was used, with a focus on pattern matching (i.e. where empirical patterns are compared with those that have been predicted in the literature and/or any previous empirical work, in an attempt to explain behaviour). The fieldwork itself consisted of two on-farm interviews and a journal in which the interviewees recorded data regarding their technological learning for the seven days following the initial interview. In some instances the farmer's spouse or partner participated in the interview, which provided a degree of informal data triangulation.

RESULTS

This section presents some of the key findings from elements of the data collection phase. The key themes from components are also summarised and discussed in relation to each other. Whilst the questionnaire yielded a great deal of detailed data it is not provided here as much of it will be reported in detail elsewhere (e.g. forthcoming articles by Flett, Humphries, Alpass, Long, Massey, & Morriss; Humphries, Alpass, Flett, Long, Massey, & Morris).

Forum

While the primary purpose of the forum was to help the research team identify issues that could be further developed in the cases, interviews and questionnaire, it also produced a set of stand-alone results. Working as individuals as well as in groups, the participants started by producing a list of the key institutions involved in the industry. In an exercise that asked them to assess the relative importance of each of the institutions, they produced 'maps' of the way in which these institutions interact. While the results produced from the groups differed (see Figure 2 for the two maps that were both produced by groups of farmers), there were a number of points of agreement between the four groups, and some conclusions that the researchers were able to reach in the context of the research question:

- Organisations/institutions of importance within the industry are easy to identify.
- Industry participants found it easy to assess which organisations and/or institutions had better relationships with farmers.
- Industry participants could see where barriers lie.
- The industry has been undergoing significant change and this has created a situation where institutional/industry structures, dynamics and inter-relationships have impacted negatively on on-farm technological learning.

Interviews

This theme (of change) was developed further in the industry interviews, where a key message was that farming systems have changed in the last two decades. For example, twenty years ago extension agencies were seeking to facilitate the adoption of what could be described as 'generic' technologies, i.e. those that had application on the majority of dairy farms (e.g. milking techniques, pasture measurement, and high stocking rate systems). Those interviewed suggested that far fewer 'new' technologies and systems had been developed in the last 15 years. The main farming systems change in recent years has been one of scale, with a significant increase in average herd size, and rapid growth in the number of large herds (500+ cows) - there is now far greater diversity in farm business structure and goals of farmers. Therefore the context for extension agents now is one where on-farm change pertains to very personal decisions. This implies a greater need for one-to-one change support systems than a generic extension service can and does provide.

In keeping with this theme, questions were raised about the relevance of a generic industry goal

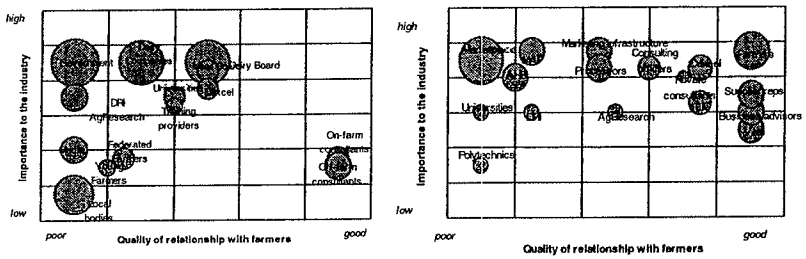
targeting productivity improvement. It was suggested that, given the personal nature of change decisions, a 'better' concept is performance improvement, as this concept captures the attainment of all goals of farming people, not just productivity.

It was also suggested that the New Zealand on-farm dairy innovation system still needs to shift toward a better balance between demonstration of applied research of relevance to farmers in their location, and pure and strategic research which is often carried out at a distance from farmers. It was suggested that the increased accountability of farmer funded research under a Commodity Levy was only likely to increase the pressure for more applied research.

One clear point from the interviews was that the on-farm dairy innovation system is much more fragmented than it was in the past. There are many more organisations involved in on-farm research and in facilitating change on farms, and each of these organisations is individually commercially motivated. This has created a less co-operative and more competitive innovation environment, despite the industry retaining the co-operative structure. In this environment, there is a greater need to provide clarity as to where farmers should and can go to get the information they seek. Currently roles and responsibilities in the innovation system are not at all clear. It was suggested that there was institutional overlap developing, for example between the dairy companies funded from milk sales proceeds, and between extension organisations funded in the future from farmer levy.

Within this fragmented innovation system, with potential and actual overlap, the question of industry co-ordination was raised, particularly in relation to research. An unanswered question at this stage is to what extent the industry should seek to co-ordinate the activities of participants in the innovation system as against allow a competitive market to dictate its direction.

Figure 2: Relationships between farmers & industry organisations/groups



Case Studies

The researchers used data from the forum and the interviews as the basis for designing the case studies. For example, the researchers showed the interviewees the maps from the forum and asked them to comment on how their perceptions matched those expressed in the maps. They also asked them to respond to different theoretical statements that had been identified from the literature at the beginning of the project e.g. "the speed with which farmers engage in technological learning will be influenced by their age". The results of these worksheets are presented in Figure 3. There were several interesting things about these results:

- There were instances when the farmers agreed with the statement derived from the literature (e.g. the influence of a farmer's goals on the speed with which they engage in technological learning).
- There were also instances when the farmer's responses to the statements differed according to their membership of the 'small' or 'large' farm group (e.g. the level of engagement with the innovation system will influence the speed with which farmers engage in technological learning).
- There were several instances in which the farmers disagreed with a statement that was derived from the literature (e.g. the farmers disagreed that farm size influenced the speed with which they engaged in technological learning).
- There were a number of instances where the responses of farming couples differed (e.g. Case 1 & 2 of the large farms sub-sample).

	LARGE FARMS				*SMALL FARMS*			
Statement	**Case 1***	**Case 2***	**Case 3**	**Case 4**	**Case 1**	**Case 2**	**Case 3**	**Case 4**
The speed with which farmers engage in technological learning will be influenced by their goals	Agree (Unsure)	Agree (Strongly agree)	Agree	Agree	Agree	Agree	Agree	Agree
The speed with which farmers engage in technological learning will be influenced by their level of competency	Unsure (Disagree)	Agree	Unsure	Unsure	Disagree	Strongly agree	Agree	Agree
The speed with which farmers engage in technological learning will be influenced by their age	Disagree (Strongly disagree)	Agree (Unsure)	Disagree	Disagree	Disagree	Agree	Agree	Unsure
The speed with which farmers engage in technological learning will be influenced by the level of productivity/output of the farm	Agree	Unsure (Disagree)	Agree	Disagree	Disagree	Agree	Disagree	Disagree
The speed with which farmers engage in technological learning will be influenced by their level of engagement with the innovation system	Agree (Strongly agree)	Agree	Agree	Agree	Disagree	Agree	Disagree	Strongly agree
The speed with which farmers engage in technological learning will be influenced byinstitutional activites, linkages, interactions & misalignments	Agree	Agree (Strongly agree)	Agree	Strongly agree	Agree	Agree	Disagree	Agree
The speed with which farmers engage in technological learning will be influenced by their role in the farm	Disagree (Strongly agree)	Agree	Agree	Strongly agree	Agree	Agree	Agree	Agree
The speed with which farmers engage in technological learning will be influenced by farm size	Disagree	Strongly disagree (Disagree)	Strongly disagree	Unsure	Disagree	Disagree	Strongly disagree	Disagree

Figure 3: Responses to the theoretical statements

* Responses in brackets represent contrasting responses made by the secondary decision-maker

In order to gain a deeper understanding of the actual process of TL, interviewees were also asked to keep a diary. In the diary they were specifically asked to describe a practical situation where TL has occurred in the past (see box for the instructions). They were then asked to describe aspects of technological learning that occurred in the seven days following the initial interview. This diary was posted to the researchers, and in the second interview the responses were explored in detail.

Figure 4: Diary instructions to respondents

> On the blue pages we would like you to describe a situation where you were engaged in 'technological learning', i.e. where you were able to turn information gained from research or other sources into knowledge that could be used by you on the farm. The situation will be specific to your farm and we want to know how you dealt with it, using the boxes provided.
>
> In the 'what' section describe the situation in as much detail as you can. In the 'who' section describe who you consulted and how or why they were useful. In the how section describe what actions you considered and what actions you took. Finally, in the 'skills' section describe the skills or knowledge that was useful or essential. It would also be helpful if you indicated the timing related to the situation (i.e. how long it took you to make a decision or find someone appropriate to talk to etc.). In order to give us as complete a picture as possible it would be helpful if you revisited this section of the journal each day you looked at the other daily section and added any other details you recall.

At the end of the case studies with large and small farms, the researchers concluded that:

- TL is not an intermittent event – some aspect of it occurred almost daily for all of the case subjects.
- Almost all the participants had a regular routine for some aspect of TL such as information gathering (e.g. "I log on to the net when I come in to make my lunch"). However, routines could also be disrupted (e.g. "I didn't do anything at all for three days in a row – the cricket was on TV"). Enacting the routine was also dependent on other priorities (e.g. "if it is raining outside, and I have nothing else to do, *then* I will pick up the Exporter").
- Family members (usually the wives, but sometimes a father or a son) can play a key have a role in one of the elements of the TL process (or sub-processes) (e.g. "my wife puts everything she thinks I should read on my desk, after binning the obvious junk").
- There were two types of TL: in the first TL was undertaken in the context of a specific context (e.g. "I decided to give maize silage a try, so I went out and found some information on it"). In the second, TL was not context specific (e.g. "I always have a bit of a browse through the Exporter – you never know what you might pick up").

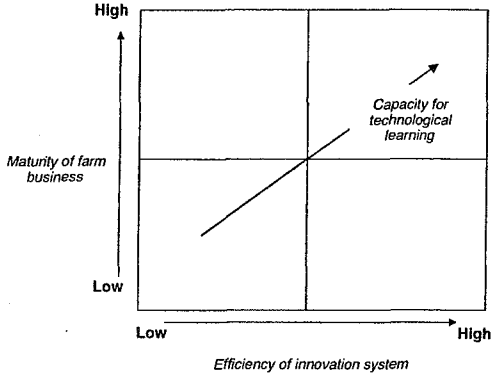
These cases enabled the researchers to confirm some of the suggestions of previous research; namely, that there are a number of situational influences on whether individuals engage in technological learning.

CONCLUSIONS

As noted in the introduction, past research on technology adoption suggests that different factors influence adoption and the speed with which it is undertaken. Some of these general factors were also confirmed by our data, and in a related context (that of technological learning) it can be seen that the characteristics of the individual, the farm system and the innovation system all interact to influence the rate at which individuals engage in TL.

Figure 5 provides a way of conceptualising the different influences on TL that are presented in the research data. They can be grouped into three broad categories. The first category includes those factors that relate to the farm business (financial stability, level of debt, herd quality etc). The second category includes factors that relate to the efficiency of the innovation system, such as the presence of extension and consultancy providers, the availability of information through magazines and newsletters and the ease with which individuals can access information through means such as the Internet. The third category relates to the individual's characteristics, such as age, level of education, confidence, innovation capacity etc. As the model suggests these three sets of factors interact.

Figure 5: Influences on technological learning



Additionally, by reviewing the case material in the context of the industry interviews, the forum and the questionnaire, the researchers were also able to broaden their original concept of TL. This was initially conceived of as a simple process model whereby information inputs were transformed into knowledge (that would then be used in the context of farm management). However, our data suggest that technological learning can take several different forms, in terms of a number of dimensions of comparison. Firstly, TL can be purposeful or it can be done without any specific objective in mind. The second difference is in the way in which the TL process is conceived. One view of TL is as a simple process where information is turned into knowledge. Here TL encompasses sub-processes such as information gathering and decision-making. But TL can also be viewed as a sub-process that is part of an organisational meta-process such as decision-making and/or management.

These distinctions are relevant for all those who are interested in increasing the speed with which farmers engage in technological learning: if TL is linked to a specific objective then it appears that individuals will be more motivated to engage in the process. Interventions to increase the speed should focus on identifying and targeting those individuals who are highly motivated. However, those individuals who engage in TL without any specific purpose in mind are also important; the key here may with assistance with simple interventions such as training on searching the web.

From the perspective of industry associations and others with an interest in the speed with which individuals engage in 'a learning process' this is useful information: while many of these factors are not controllable, there are others that are. In addition, the issue of control is not always the key issue; merely having a framework that can help group those individuals with the most potential to engage in TL can be useful. The framework in Figure 5 should assist those groups that wish to speed up TL by depicting how optimal congruence between the sets of influences will enhance the speed of uptake.

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Dairy Farming – Trends Over Time

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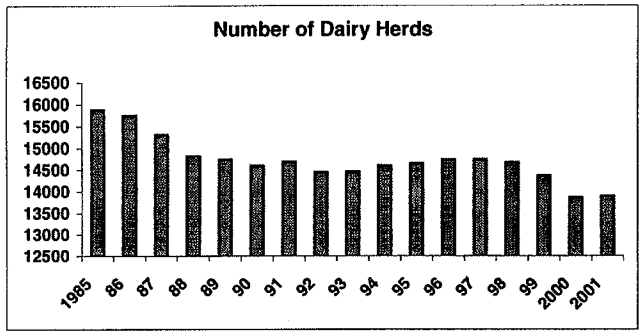
Abstract

This paper reviews a range of statistics which investigates how dairy farms are changing in size, intensity and level of production, both nationally and by region. It will look at the increase in the area of land over the last 10 years, and make some predictions, by region, for growth over the next 10 years. It will examine profitability trends, and how the rate of growth in on-farm expenditure is tracking ahead of income. It shows that while the nominal payout over time has been increasing, the real payout continues to decline. It will also discuss rates of return on capital and how they have trended, and will discuss some future issues such as availability of capital, water, and labour.

Physical Trends

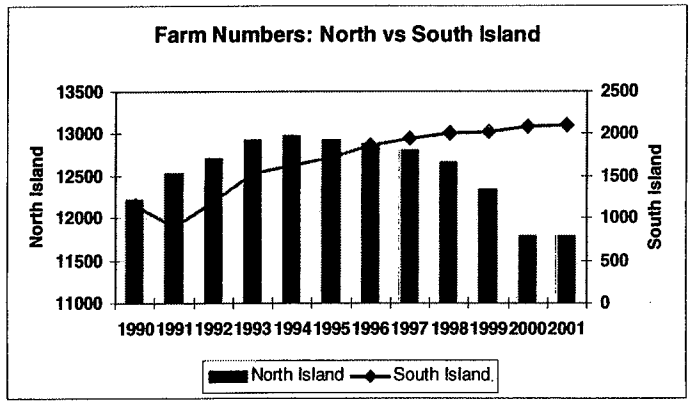
This paper examines a number of the trends and changes in dairy farming in New Zealand over the last 15 years. In a general sense, farms are getting fewer in number, but much larger and more intensive. Figure 1 shows farm numbers have decreased from around 15,900 in 1985, to 13,900 at June 30 2001. The main decrease in farm numbers has been in the more traditional dairying areas, mostly via amalgamation or the smaller units dropping out all together. Growth in farm numbers has occurred via drystock conversions, especially in the South Island. This is illustrated in Figure 2 and Figure 3.

Figure 1



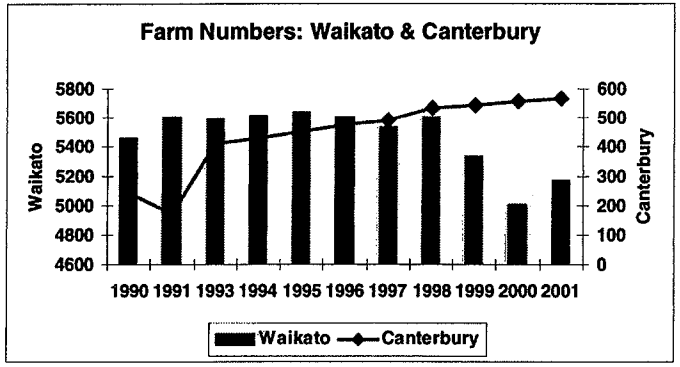
Source: LIC

Figure 2



Source: LIC

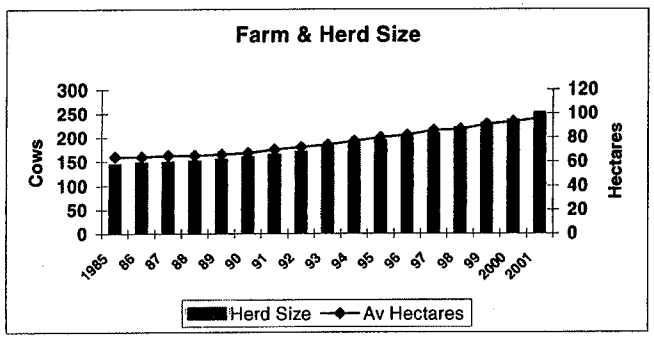
Figure 3



Source: LIC

Average farm size has increased from 64 hectares in 1985 to 96 hectares in 2001, a 50% increase (Figure 4). At the same time, average milking cow numbers wintered has risen from 144 cows to 251 cows, a 74% increase. Again there are regional differences as illustrated by Figure 5 which shows a rise from 171 cows to 240 cows in the Waikato over the last 10 years (40% increase) versus a rise from 202 to 451 (123% increase) in Canterbury. Average farm size has lifted from 65 hectares to 85.4 hectares (31%) in the Waikato, and from 96.3 hectares to 157.7 hectares (64%) in Canterbury (Figure 6).

Figure 4



Source: LIC

Figure 5

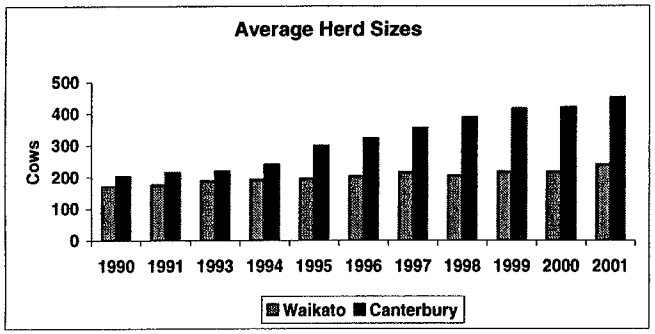


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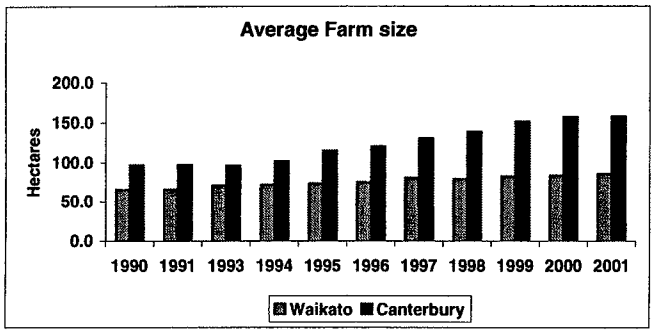
Figure 6

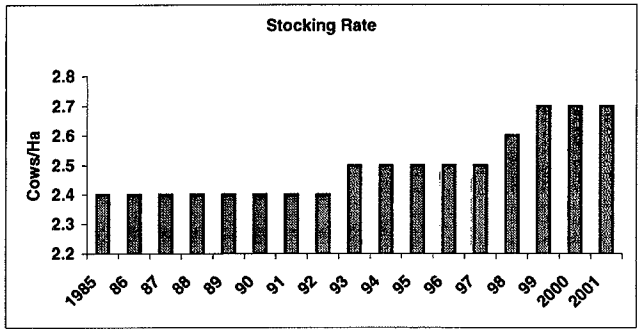


Source: LIC

Given that average herd sizes have risen faster than farm size, stocking rates have also increased. Figure 6 shows that they have lifted in discrete jumps, from 2.4

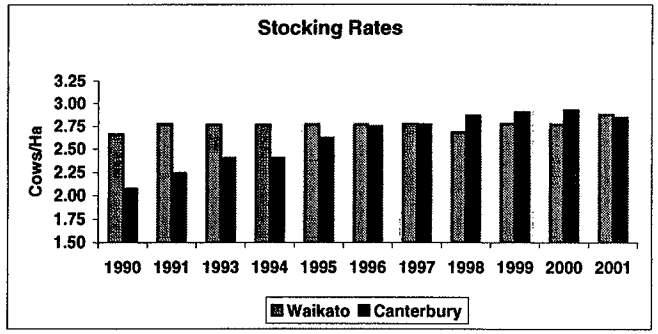
cows/ha in 1985 to 2.7 cows/ha in 2001. In the Waikato, stocking rate has risen slowly compared with a more rapid rise in Canterbury (Figure 8).

Figure 7



Source: LIC

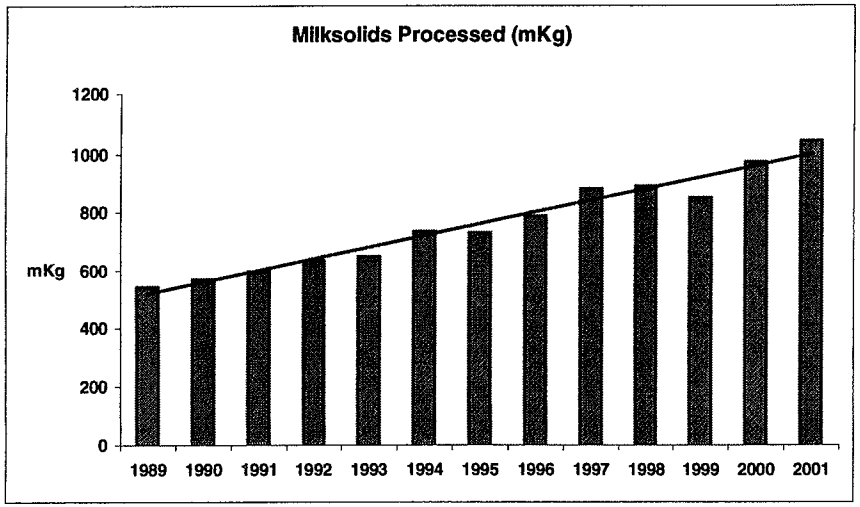
Figure 8



Source: LIC

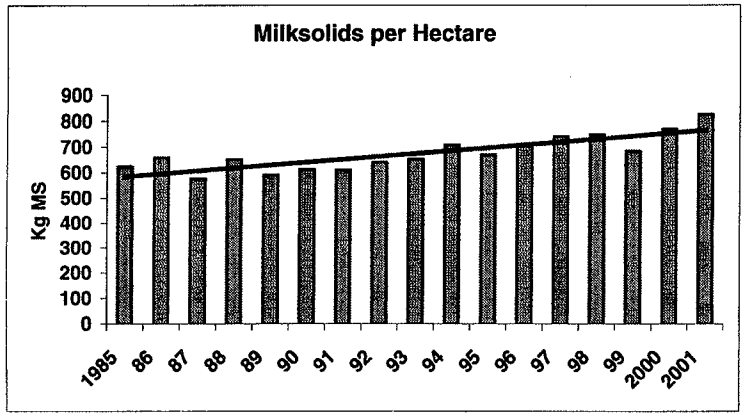
Milk solids production has increased directly in line with increased cow numbers (Figure 9), while production per hectare has risen 32% over the 15 year period 1985 – 2001 as shown in Figure 10.

Figure 9



Source: MAF

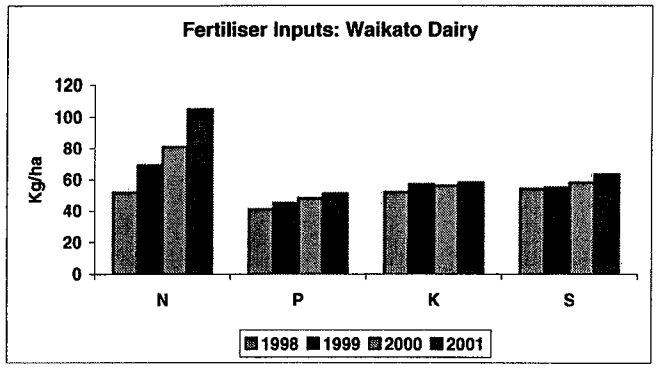
Figure 10



Source: LIC

Fertiliser input, at least in the Waikato, has only risen slightly with respect to PK & S inputs/hectares, while nitrogen use has lifted significantly (Figure 11). A lot of dairy farmers apply above maintenance levels of PKS fertilisers, and the high, and increasing rate of N fertiliser use is of concern environmentally.

Figure 11

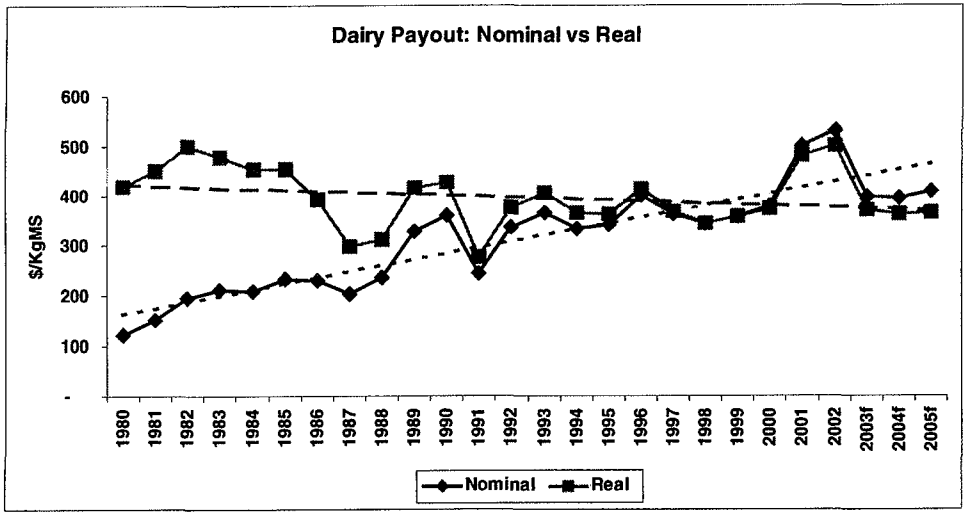


Source: Ballance Agri-Nutrients

Economic Trends

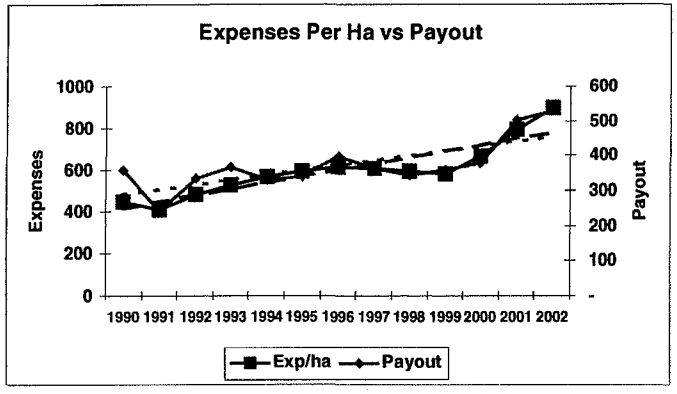
At the payout level, nominal returns continue to rise, while real returns ($/kg Milksolids) continue their long term decline (Figure 12). At the on-farm level, the rate of spending on farm expenditure over the last ten years has outstripped the rate of increase in the payout, and the rate of increase in production levels (Figure 13, 14). The concern here is that dairy farmers are building costs into their systems, which means they will have difficulty in handling a major downturn in payout.

Figure 12



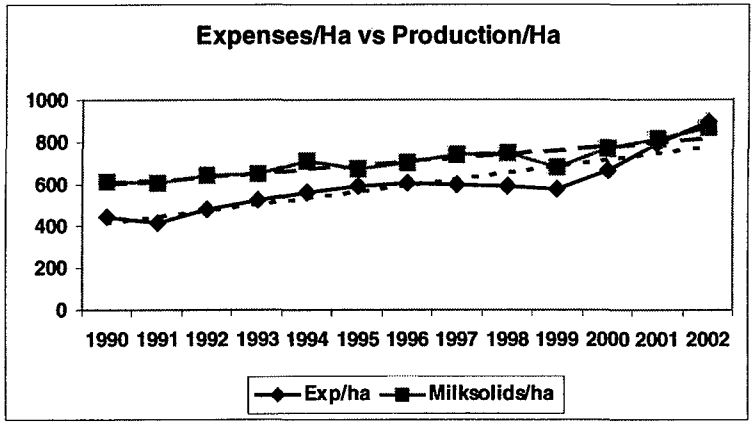
Source: MAF

Figure 13



Source: MAF

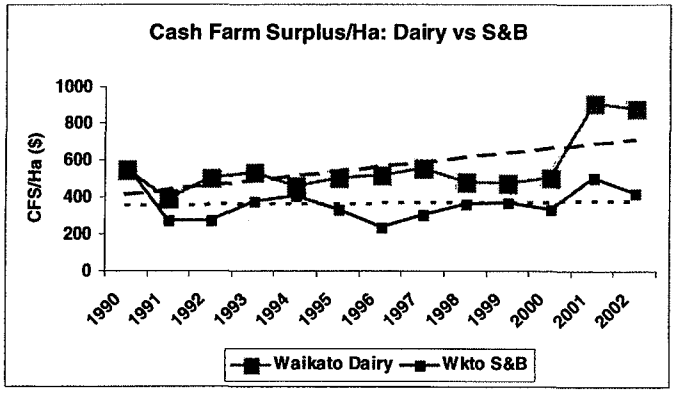
Figure 14



Source: MAF

The incentive to convert drystock farms to dairying can be illustrated by comparing the profitability of dairying with intensive sheep and beef in the Waikato. This shows not only a higher absolute profitability but also an increasing greater relative profitability to dairying (Figure 15).

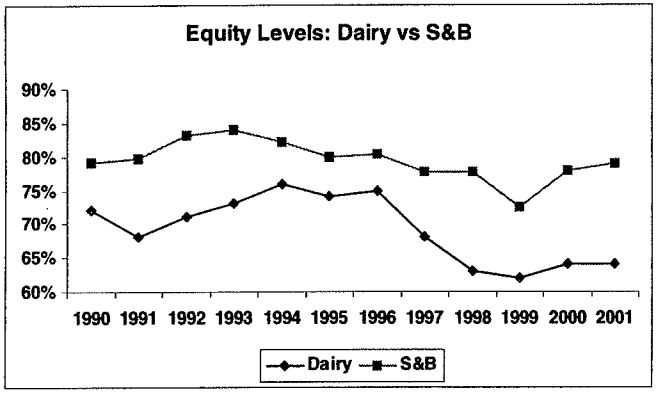
Figure 15



Source: MAF

Dairy farm equity levels improved over the early 1990's rising from 72% in 1990 to 76% in 1994, before dropping rapidly over the latter 1990's to 62% in 1999, before rising to 64% in 2001 (Figure 16). Given a rapid rise in land prices from 2000 onwards, the relatively constant equity level would infer a equally major rise in borrowing by dairy farmers. Sheep and beef equity levels also rose in the early 1990's, from 79% in 1990 to 84% in 1993, before slipping again through the rest of the decade, then rising back to 79% in 2001.

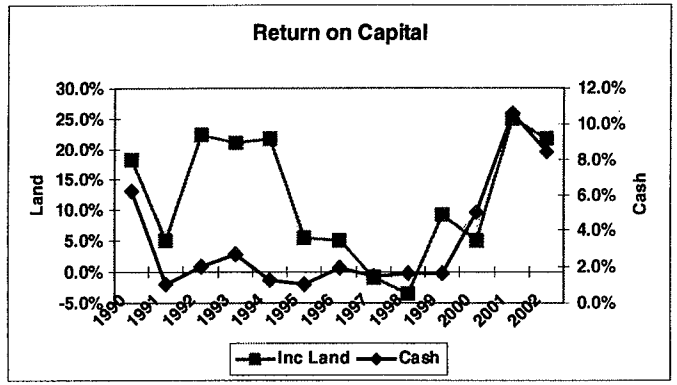
Figure 16



Source: Dexcel, MWES

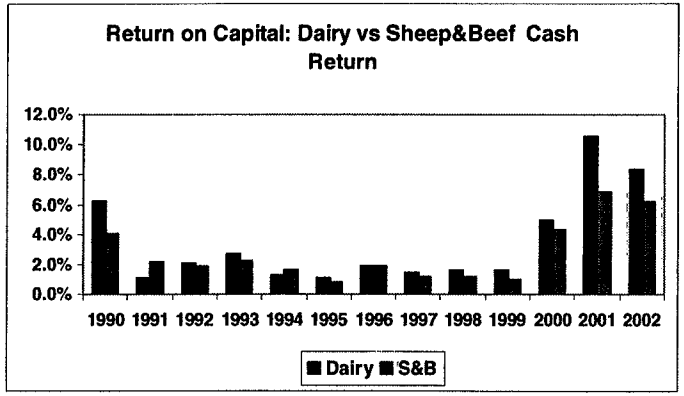
Return on capital has fluctuated widely over the 1990's through to 2002. The average return on capital, calculated as economic farm surplus (EFS) divided by total farm capital (TFC) is 3.46% over this period. If the change in land value is included, average return on capital from 1990 to 2002 is 12.0% (Figure 17). Figure 18 compares the return on capital (EFS/TFC) from dairying versus sheep and beef. The average return from sheep and beef farming over this period was 2.75%.

Figure 17



Source: LIC, Dexcel, MAF

Figure 18



Source: LIC, Dexcel, MWES, MAF

Labour

Good statistics on labour are scarce. The Census data shown in Table 1 shows a 4% increase in full time dairy farming employment from 1991 to 2001, a 49% increase in part time employment, and a 11% increase in total employment.

Table 1

Employment: Dairy Farming			
Year	Full Time	Part Time	Total
1991	26,868	4,755	31,623
1996	27,252	8,025	35,277
2001	27,963	7,074	35,037

Source: Stats NZ

Relating this to cow numbers, it shows 1 full time employee per:

1991: 90 cows
1996: 108 cows
2001: 125 cows

Future Trends

To give an idea of the extent of land converted to dairying, an extra 589,000 hectares was in dairying in 2000 compared with 1990, with a prediction of a further 265,000 hectares by 2010 (Table 2).

Table 2:

CHANGE IN DAIRY AREAS (ha)

	1990	2000	% Change	2010	% Change
Northland	123,070	186,869	52%	188,738	1%
Auckland	41,461	61,340	48%	61,953	1%
Waikato	420,585	516,183	23%	554,897	8%
Bay of Plenty	95,721	97,049	1%	104,328	8%
Hawkes Bay	9,627	14,456	50%	20,238	40%
Taranaki	151,236	209,572	39%	234,301	12%
Manawatu/Wanganui	75,790	129,494	71%	161,868	25%
Wellington/Wairarapa	38,876	37,992	-2%	41,791	10%
Tasman	12,663	29,607	134%	37,749	28%
Marlborough	7,947	10,197	28%	10,707	5%
West Coast	26,749	62,841	135%	69,125	10%
Canterbury	23,207	134,529	480%	195,067	45%
Otago	11,159	59,960	437%	89,940	50%
Southland	12,708	89,955	608%	134,933	50%
Total New Zealand	1,050,799	1,640,044	56%	1,905,635	16%

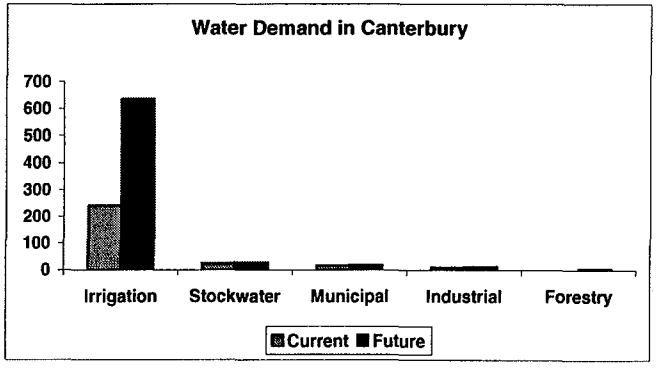
Source: MAF

The predicted increase is dependent on a range of factors, including (obviously) profitability trends. Current indications are that the expense of converting drystock land, and/or amalgamating smaller dairy farms has showed conversions. The rapid increase in land prices, coupled with the increasing cost of purchasing shares in Fonterra (at total of $4.80/kgMS in 2002/03; $3.85kgMS for Company shares plus around 95c/kgMS for peak notes) has made converting farms less economically viable, especially in the face of $4/kgMS payouts.

A significant physical aspect will be water, as many new dairy properties, especially in regions such as Canterbury, Hawkes Bay, and Wairarapa, will need to be irrigated.

The issue can be illustrated by the Canterbury situation. Figure 19 shows the relative current and future demand for water in Canterbury, illustrating the dominance of agriculture. Currently there is 400,000 hectares irrigated in Canterbury, with a potential of over 1 million hectares. Current peak water demand is 242 cumecs; future demand will be in the region of 636 cumecs. This amount of water is available at a regional level. However, most of the current dairy expansion is in the small catchments. This means that the larger rivers will need to be tapped, with the water transported and/or stored elsewhere for use. All of which raises significant economic, political, and environmental issues.

Figure 19



Source: ECan

Looking to the future, current trends would suggest:

- Dairying will continue to expand
- There will be fewer but bigger farms
- There are likely to be more "corporate" farms (eg: equity partnerships, family corporates)

Apart from the economics of dairying relative to other land users, there will be a number of factors which affect this expansion, such as:

- Capital requirements, both on-farm and at an industry level,
- Water issues, both quantity and quality,

- Plus other environmental issues such as environmental management systems for market requirements, and carbon taxes.
- Other developments such as robotic milking, could well revolutionise the industry. But that's another story.

Conclusion

The number of dairy farms in New Zealand is decreasing, with farms becoming bigger and more intensive. Currently there is a major increase in dairying in the South Island, mostly Southland and Canterbury. Fertiliser inputs are increasing, dramatically so for nitrogen.

Economically, dairying remains a very profitable form of pastoral farming, with absolute and relative returns well ahead of sheep and beef farming. Returns on capital from land appreciation continues to be well ahead of cash returns.

The expansion of dairying is likely to continue, albeit restrained by increasing demand for capital, shortage of labour, and environmental concerns.

An Economic Analysis of the South Waikato

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Abstract

Rural New Zealand has had a mixed economic experience in recent decades. Some districts have experience economic rejuvenation whilst others have faced economic decline. The South Waikato District has suffered significant population loss whilst having significant dairy and forestry investments. This paper provides a statistical description of the recent history of the South Waikato economy. It includes analysis of GDP, employment and valued added in the South Waikato Economy. These statistics are compared with the neighbouring urban areas of Hamilton, Rotorua, Tauranga and Taupo. The papers proceed to consider possible regional development strategies given the existing situation. The paper concludes with discussion of possible futures for the South Waikato economy given its existing economic base and regional possibilities.

Section 1 Introduction

Waikato is the fourth largest region and has the fourth biggest regional population in New Zealand. The region depends heavily on agriculture and forestry industries for much of its wealth. South Waikato is one of the Districts contributes to the region's primary product exports. The rapid development of forest industry and the establishment of the Kinleith mill in the early 1950s have helped the District to build a strong base for forestry operations in the nation and in the world. However, the Kinleith heavy job cuts during the last decade have left the District with high unemployment, a low-skilled labour force and continuing contraction of population and local business activities. In recent years, the central government has been actively advocating Regional Partnership Programme in an attempt to provide support to rebuild the depressed regions in New Zealand. It is the purpose of this paper to provide an analysis of the current socio-economic characteristics and economic activities of the South Waikato as a contribution towards developing an effective economic development strategy for the District.

The first section of this paper covers the economic profile of the Waikato region. It then goes on to analyse the economy activities, people and quality of life of the South Waikato. The data is based on the Statistics New Zealand Census Data between 1996-2001. Particular attention is paid to finding the key sectors and potential sectors of which are and could create wealth for the District. The analysis is based on a 114-sector economic model using 2001 employment and 2001 prices, which is the most up-to-date model available. The final section summarises the main points and draws out possible economic development strategy for South Waikato.

Section 2 The Waikato Regional Economic Profile

The Waikato region is the fourth largest region in New Zealand, covering most of the central North Island. In Census 2001, 357,726 people lived in the Waikato region, making it the fourth largest regional population after the Auckland, Canterbury and Wellington regions. Between 1996 and 2001, the population in the region grew by 2.2 percent, which is the eighth fastest growing region out of the 16 regions in the country (Environment Waikato, 2002). The region also has a youthful population compares to the national average whilst the Maori population is slightly higher than the national average. NZ European, Maori and Pacific Islanders are the three main ethnic groups that comprise the people of Waikato. Excluding English, Maori is the second most commonly spoken language in the region. In 2001, the percentage of people in the Waikato region with income over $30,000 per year is slightly lower than the national average.

The following table indicates that the Waikato region depends heavily on agriculture and forestry and tourism sectors for much of the region's wealth. The region also supplies most of the North Island's generating capacity. The Taupo District provides the most energy production in the region, followed by the Waikato and Waipa Districts. In addition, the Waikato District has the most minerals in the region. Timber processing and primary processing are the most common industries across the Districts and the same is for the rock and gravel quarry sector. The Hauraki District has the only gold mining activity in the region. Most Districts use the 'clean-green' image and local culture and heritage as their comparative advantages in the tourism industry. For instance, besides offering the clean-green image, Hauraki is included in the Coromandel region which has hot water beach. Hamilton has the largest indoor/outdoor aquatic centre in New Zealand. In addition, Waitomo Caves, Lake Taupo and Tongariro National Park are also other

major tourist destinations in the region. In order to sustain the comparative advantage in the tourism industry, the region seeks to focus on maintaining the quality of its natural environment and heritages to meet the demands for the increasing numbers of tourists and holidaymakers.

In the Waikato region, 58 percent of the land has been used for pastoral farming whilst 12 percent is used for exotic forestry (Environment Waikato, 2002). Given an economy heavily dependent on land, it is important the land is maintained. This calls for a sustainable development strategy that not only promotes for economic growth but also harmonises the natural environment and increases the future quality of life. The next section gives an in-depth economic analysis of the South Waikato economy, which later will be used as a base for creating a sustainable economic development strategy.

Section 3 What is Economic Development?

Economic development is essentially about enhancing the factors of productive capacity – land, labour, capital, and technology – of a national, state or local economy (U.S. Department of Commerce Economic Development Administration, 2001). To most economists, economic development equates with economic growth, while some may argue the term must include complex issues[1]. Economic developments policies often arise because of the distress with unequal regional economic development and its social and political consequences (Bryant, 1984). Many rural areas face economic and community development issues due to their geographic

[1] Economic development is perceived differently across different fields. Environmentalists may interpret economic development is an issue of sustainable development that harmonises natural and social systems whilst community-based leaders and professionals may see it is a way to strengthen inner city and rural economies in order to reduce poverty and inequality. See the US Department of Commerce Economic Development Administration website for more discussion.

isolation of communities separated by long distances, absence of entrepreneurs, historic dependences on agriculture, continued population loss and out-migration and economic distress. Traditional rural development policies mainly concerned with the equitable geographical distribution of resources[2] and treat rural areas as homogenous with uniform problems and opportunities in the hope that they can lead to regional equilibrium. For years, attempts in the United States have been made to change rural policies incrementally and most of these approaches have largely failed (Stauber, 2001).

Establishing a successful rural policy has long been a challenge for central government. On the one hand, rural policies focus on manufacturing and agriculture sectors are said to bring economic prosperity (Pezzini, 2000), whilst others argue such approaches are often ineffective[3] (Stauber, 2001). Despite the debate, more countries are providing support for the 'development-from-below' approach. At the state level, partnerships with local government or territorial councils, private and non-profit sectors are found more effective in meeting rural residents' social needs and solving economic issues according to their own regions (Pezzini, 2000).

Characteristics of economic development strategy

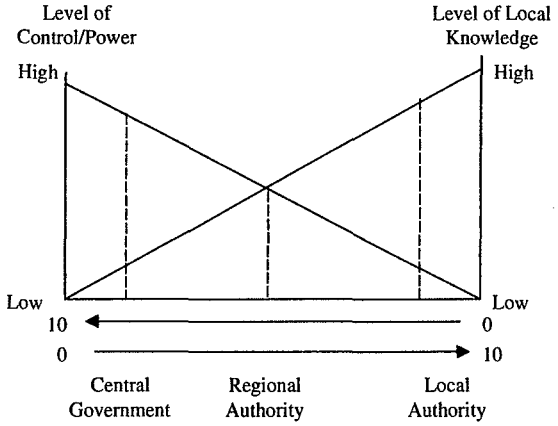
In recent years many developed countries such as Britain, United Sates and Australia have adopted the 'bottom-up' strategy for their lagging regions rather than using prosperous regions as the main vehicle for economic growth. The increasing popularity of such an approach is due to its sustainability and inter-ministry activities through the utilisation of local resources and the involvement of local community to facilitate the region's development. Moreover, not only this

[2] Traditional rural policies focused only on establishing sound macroeconomic policies (ensuring national growth together with stable prices and healthy government finances) and structural policies (improving the efficiency of markets) which are not sufficient and appropriate to solve regional economic disparities (Pezzini, 2000).

approach helps the locals to establish their competitive advantage (by responding and exploiting local opportunities), it also takes quality of life factor as part of the development strategy. The scale of regional development strategy efficiency next page reveals that while central government has the highest level of control during the strategy formation process, it has the lowest level of local knowledge than that of regional and local authorities. Conversely, although the local authority has the weakest level of control during the strategy formation, it has the best knowledge of local's social, economic and environmental profile. The diagram shows that, without the fundamental communication and cooperation from both sides, no efficiency can be achieved. The bottom-up strategy works efficiently because of its local to regional characteristic approach. This means that by communicating and networking with local communities, common goals can be attained and strategic partnerships (including private and non-private sector) can be formed effectively This results in providing the best practice that facilitates a sustainable development for the lagging communities and fasten the development process for the entire region. As the level of government's involvement varies across different regional economic, social and environmental characteristics, the next section identifies the eight types of economic development strategies to assist the government applying appropriate strategy to minimise regional disparities.

[3] The intensification of farming may in turn reduce risk-taking behaviour and entrepreneurship in rural areas. Targeting on manufacturing sector will only bring low-wage, low-skill employees into rural areas (Stauber, 2001).

Regional Development Strategy Efficiency Scale



Different Approaches of Economic Development Strategies

Wiewel, Teitz and Giloth (1993) have identified eight forms of economic development strategies and these have been summarised in Table 7 in Appendix 7. While business retention strategy focuses on retaining the existing businesses and industrial districts within a region, commercial revitalisation strategy emphasises on the collaboration of neighbourhood businesses to form a common interest and to compete with other regions. Development of business ventures strategy encourages businesses to hire locally and to spend locally to strengthen the region's economy. On the other hand, entrepreneurship strategy seeks to establish homegrown entrepreneurs to enhance the ownership, employment and development in the region. Employment, training and placement strategy focuses on upgrading or utilising local human resources and to explore opportunities in the region whilst labour-based development strategy emphasis on attracting higher wage jobs,

particularly those have potential for growth and clustering in the region. Finally, community organising or planning strategy promotes neighbourhood communities to have ownership of their local resources and opportunities to intensify local connection and economy. In all, each approach is applied based on a region's social, economic and environmental characteristics. Possible ways to solve local business problems have been summarised in the Implication section in Table 7. In addition, while it is important to have a sound economic strategy, regions should also base their strategies on social and political harmonisation in order to achieve sustainable development.

Section 4 Economic Activity in the South Waikato

Economic Resource Base

Table 5.2 in Appendix 5 reveals the rural orientation of South Waikato. As agriculture, forestry and fishing, and the manufacturing industries have a larger share when compared to the other Districts. At the 2001 Census, 21.1% of the business activities in South Waikato are involved in agriculture, forestry and fishing sector compared with 2.4% in Hamilton, 12.4% in Taupo and 3.8% in Tauranga. Also 22.5% of business activities in South Waikato are in the manufacturing sector, the highest in comparison to the rest of the Districts.

Business Operations

Table 5.3 and Table 5.4 in Appendix 5 show that proportionately more people of working age in South Waikato are working in lower-paying occupations and only had small pay increases over the 10 years. At the time of the 2001 Census, occupations in agriculture and mining and manufacturing industries in South Waikato are the 8th and the 13th highest per hour pay out of the

total of 15 industries in New Zealand. By contrast, more people of working age in Hamilton and Tauranga are engaged in the property and business services sector[4] (the 5th highest pay industry), although it has a lower percentage of pay increase when compared to the manufacturing industry over the last 10 years.

Employment and Unemployment

Despites an upward trend in unemployment for each district, South Waikato has the highest unemployment rate with 10.3 percent (see Table 1 below).

Table 1 Unemployment Rate

	South Waikato District	Hamilton District	Taupo District	Tauranga District
2001	10.3%	9.9%	7.7%	9.0%
1996	7.8%	6.2%	5.5%	5.5%

Source: Statistics New Zealand Census Data

Such a high rate may partly due to the rural nature of the district and the high proportion of Maori and Pacific Island residents without formal qualifications. Also the opportunity to engage in skilled occupations is more likely to be in urbanised areas. The large amount of forestland in South Waikato has being milled locally result in a high proportion of people being employed in the wood and paper product manufacturing industry. This is evident in Table 5.1 in Appendix 5 which shows a high proportion of residents' occupation is involved in agriculture, forestry and fishing industry (20.7% compared with 2.5% in Hamilton, 13.4% in Taupo and 4.5% in Tauranga).

Plant and machine operators and assemblers is another major occupation group for South Waikato working age residents. Table 5.1 also reveals the ratio of professional to the population

[4] At the time of the 2001 Census, the three largest industries for employed working age residents in both Hamilton and Tauranga were in the following order: Retail trade, manufacturing and property and business services.

is lower in South Waikato when compared with other Districts. Again, the large rural population may be a prohibiting factor for the South Waikato people engaging in professional occupations.

Personal Income and Inequality

The South Waikato residents median income level has increased from $14,802 at the 1996 Census to $17,600 at the 2001 Census (See Table 4.1 in Appendix 4). Overall, the median income gap between the South Waikato and other neighbourhood Districts have improved, particularly with respect to the Hamilton and Taupo Districts. The sources of income for each district are described below.

Sources of Income

At the 2001 Census, 50.4% of the South Waikato residents of working age receive income from wages, salaries, commissions, bonuses etc paid by employer, the lowest compared to Hamilton with 60.7%, Taupo with 54.5% and Tauranga with 51.6% (see Table 4.2 in Appendix 4).

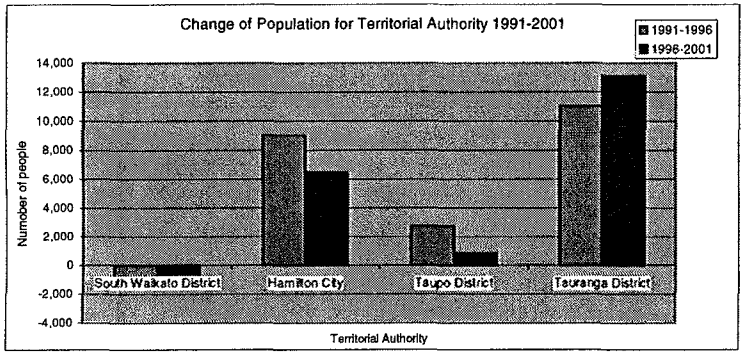
Table 4.2 in Appendix 4 reveals Hamilton has the highest proportion of people depend on the community wage job seeker as a source of income with 9.1%, followed by South Waikato with 7.4%, Tauranga with 7.3% and Taupo with 6.9%. On the other hand, the proportion of South Waikato residents receiving the Domestic Purposes Benefit (6.5%) is the highest compared to Hamilton (4.7%), Taupo (5.0%) and Tauranga (4.6%).

Section 5 People of the South Waikato

Population Characteristics

At the time of the 2001 Census, South Waikato with 23,472 people has the smallest residential population relative to the neighbouring regions. This is followed by Taupo with 31,521 people, Tauranga with 90,906 people and Hamilton with 114,921 people. Figure 1 shows that, between 1991-2001, South Waikato is the only region that experienced population decline with a loss of 2,937 people. Moreover, Table 1 reveals the trend of population decline is expected to continue over the next twenty decades.

Figure 1 Change of Population for Territorial Authority 1991-2001



Source: Statistics New Zealand Census

Table 1 Projected Resident Population of Territorial Authority Areas
1996(Base)-2021 (May 2000 Release)

Area	Year at 30 June					Change 2001-2021	
	2001	2006	2011	2016	2021	Number	Percent
South Waikato District	23,400	22,800	22,000	21,000	20,100	-3,300	-14.1%
Hamilton City	119,800	126,700	133,400	140,000	146,700	26,900	22.5%
Taupo District	32,700	33,800	34,500	35,200	35,700	3,000	9.2%
Tauranga District	91,800	100,900	109,700	118,400	127,300	35,500	38.7%

Source: Statistics New Zealand Census

Age Structure

The age sex structure diagrams in Appendix 1 show that South Waikato has a relatively high

proportion of the school age population in the 5-14 age group with 19.5%, followed by Taupo with 16.6%, Hamilton with 15.0% and Tauranga with 14.6%. In addition, 26.6% of the Maori population in South Waikato are aged between 5-14 years old, the highest compared with Hamilton with 23.2%, Taupo and Tauranga both with 24.7%. Overall, South Waikato can be said to have a relatively youthful population structure.

Ethnicity

At the time of the 2001 Census, the population of South Waikato comprised three main ethnicities: European, Maori and Pacific Islanders (see Appendix 2). The proportion of people identifying with one or more European ethnicities in South Waikato is relatively low. Only 70.8% of the residents in South Waikato identified themselves as Europeans compared to Hamilton (78.7%), Taupo (77.9%) and Tauranga (87.7%). On the other hand, a high proportion of Maori ethnicity is presented in South Waikato with 30.5% compared to Hamilton (19.1%), Taupo (29.3%) and Tauranga (16.1%). Finally, Pacific Island ethnicity represented 12.7% of the South Waikato population; this is about 4 times more than both of the Hamilton and Taupo and 8 times more than that of the Tauranga.

Highest Qualification

At the time of the 2001 Census, 41.1% of the population in South Waikato had no formal qualifications. Although there seems to be an increase in educational attainment, the proportion with no formal qualification still much higher than that of the Hamilton (24.6%), Taupo (31.8%) and Tauranga (11.2%) Districts. South Waikato is a district with a strong emphasis on agriculture and forestry, and these are reflected in statistics on educational attainment in Appendix 3.

Section 6 Quality of Life in the South Waikato

Cost of Living

South Waikato has the cheapest cost of weekly private rented dwellings compared to the other Districts at the time of the 2001 Census (see Table 6.1 in Appendix 6). About 5.1% of the private rented dwellings in South Waikato are under $50 per week, compared with only 2.9% in Hamilton, 3.1% in the Tauranga and 3.7% in the Taupo. Also 12.1% of the private rented dwellings cost between $50-$99 per week in South Waikato, the cheapest compared to Hamilton (9.5%), Taupo (10.3%) and Tauranga (6.4%).

Lack of Access to a Telephone

Although the number of people with no access to a telephone has dropped since the 1996 Census, South Waikato still has the highest proportion of residents live in dwellings without access to a telephone (7.1%). This is about twice more than that of Hamilton and Tauranga and similar to that of the Taupo (only about 1.0% points higher). In addition, South Waikato has the lowest rate of access to the Internet with 25.9%, compared with 38.8% in the Hamilton, 32.9% in Taupo and 33.8% in Tauranga (see Appendix 6).

Lack of Access to a Motor Vehicle

At the 2001 Census, the Territorial Authority rates for lack of access to a motor vehicle are higher for the South Waikato District when compared to the other Districts. Table 6.2 in Appendix 6 shows that about 10.6% of the South Waikato District residents lack access to a vehicle, which is relatively high compared to Hamilton (10.2%), Taupo (8.3%) and Tauranga

(7.9%) Districts.

Dwelling Type and Tenure

The dwelling type in South Waikato is structured based on separate houses (84.9%) at the time of the 2001 Census, the highest proportion compared to Hamilton (77.9%), Taupo (79.2%) and Tauranga (75.2%). By contrast, Table 6.4 shows that the proportion of private dwellings with three or more flats/houses joined together is relatively low in South Waikato (3.9%), with 3.1% and 2.7% points lower than Hamilton and Tauranga, respectively. In terms of dwelling tenure, at the 2001 Census, 64.8% of the South Waikato residents live in homes that they own (with or without a mortgage), which is relatively high compared to Hamilton (58.9%), Taupo (61.0%) and Tauranga (64.6%).

Crime Rate

There has been a drop of total crime offences in the Waikato region since 1998 and it has also been kept under the national's average since 1999 (see Table 6.6 in Appendix 6). Overall, Table 6.7 in Appendix 6 shows that the crime rate has decreased more than 7.0% in the past 12 months, below that of Auckland City and the national average.

Section 7 Economic Analysis of The South Waikato Regional Economy

The economic analysis of the South Waikato D.C. economy (SWDC) is based on a 114-sector economic model using 2001 employment and 2001 prices. It is the most up-to-date model available for this purpose.

An analysis of each of the 80 sectors (out of 114) for which there is employment in the SWDC economy is attached. The most important figure shows the dollar Value Added per FTE employee in the given sector (VA/FTE). This value must cover the gross wage or salary of a typical employee in the sector, all taxes paid to government, a return on equity or debt necessary to finance operations in the sector and the value of capital used up in operations (depreciation). Clearly this figure must be higher in capital intensive sectors such as Primary Processing and lower in sectors that could be classed as "labour intensive" such as *Bars & Restaurants.*

While we could see high VA/FTE values in some sectors, only those sectors with significant FTE employment are currently important for the SWDC economy.

TABLE 2: MOST VALUABLE SECTORS FOR THE SWDC ECONOMY

Sector	Number of FTEs	Value Added per FTE in $
Mixed Cropping	26	88,462
Dairy Farming	1460	68,829
Meat Processing	190	102,053
Dairy Processing	190	138,737
Soft Drink, Cordial & Syrup	18	276,111
Paper & Paper Products	880	140,727
Industrial Chemicals	55	125,818
Fabricated Metal Products	75	59,600
Industrial Machinery & Equipment	200	57,450
Road Freight	240	79,667

There should be no surprises in the sectors listed in Table 2. With the exception of the *Soft Drink* sector (can bottled water be that profitable?), all are related to farming and forestry activities. Note that values for all 80 sectors in the SWDC economy are listed in the attachments.

Another useful feature of the economic model is that it identifies those sectors that export or import a large percentage of their output. In this case exports and imports are defined as flows of goods and services out of and into the SWDC region. That is, SWDC could export goods to the Waikato region and import goods from the Auckland region, for example.

The arbitrary figure of 0.8 or 80% is used to identify major exporting and importing sectors. Sectors showing exports or imports higher than 80% of total sales are classified as "major" sectors for this purpose.

TABLE 3: MAJOR EXPORTING SECTORS FOR THE SWDC ECONOMY

Sector	Number of FTEs	Exporting percentage
Services to Forestry	200	84%
Logging	720	89%
Meat Processing	190	87%
Dairy Processing	190	92%
Soft Drink, Cordial & Syrup	18	96%
Sawmills	680	83%
Other Wood Products	320	87%
Paper & Paper Products	880	87%
Industrial Chemicals	55	90%

Most of the above sectors are again related to farming and forestry and show high employment numbers. These sectors already exhibit a comparative advantage for the region with significant exporting to neighbouring regions and/or overseas. By encouraging these sectors to develop further, the region would be building on a strong base. Conversely, diversification would be achieved by looking to expand other sectors and other activities in the region.

A similar analysis can be carried out for importing sectors. These are listed in Table 4.

TABLE 4: MAJOR IMPORTING SECTORS FOR THE SWDC ECONOMY

Sector	Number of FTEs	Importing percentage
Motor Vehicles	3	95%
Printing & Services	6	87%
Insurance	3	94%
Technical Services (Arch., qty. surveying etc.)	20	83%
Advertising & Marketing Services	3	90%
Other Community Services (Religious etc.)	6	86%
Horse & Dog Racing	3	81%

For the major importing sectors in Table 4, we see that the FTE employment numbers are quite low. This means that the SWDC economy by encouraging expansion in these sectors would be able to retain more value added (purchasing power) within its own region. Of course, proximity to Hamilton and Auckland means that sophisticated business services such as *Insurance* and *Advertising & Marketing Services* will continue to be supplied to SWDC from those cities to some degree.

Note that some sectors fell just under the 80% value for classification purposes. All values are listed in the attached schedules.

Section 8 An Economic Development Strategy for South Waikato

In the 1920s, there was an increasing concern for future world shortage of soft woods and at the same time, the South Waikato region was distressed by bush sickness and loosing its battle with

farm development (Munro, 1993). With the low price of land in South Waikato and coupled by the increasing soil erosion problems in New Zealand, planting Pinus radiata in South Waikato was a rational decision. By the 1940s, the first pulp and paper mail was established in Kinleith in the region and in 1993, the town was recognised as one of the largest forestry operations in the world (Munro, 1993). Although the success of Kinleith has brought the economic prosperity into South Waikato, Kinleith's job cuts during its restructuring period have also had a negative impact on the region's economy in the 1990s. The high unemployment rate with low-skilled labour force, and along with the persistent population decline all indicated that South Waikato has to develop a strategy that can stabilise the existing businesses and the brain-drain problems as well as to find a way to rebuild the region's economy.

On the basis of the analysis in Section 7, South Waikato has already established a comparative advantage in the farming and forestry sectors compared to other neighbouring regions. Table 5 summarises the current characteristics of South Waikato and has been used to determine the most suitable strategy in Appendix 7. A clear picture of the South Waikato economy shows persistent population loss and high unemployment since the 1990s results in a drop in business investments and local spending in the region. Further, these factors have also pushed companies to relocate their businesses elsewhere. The high ratio of people with no qualifications also discourages business and/or investors to hire and spend locally for operating or constructing business projects in the region.

Table 5 Current South Waikato Scenario

Demographics ✓ Out migration & further population decline projection ✓ Young population ✓ High ratio of Maori and Pacific Island ethnicities ✓ High ratio of people with no qualifications
Employment and Unemployment ✓ Highest unemployment rate among the neighbouring districts ✓ Main occupation groups are in primary and manufacturing industries
Income and Earnings ✓ Lowest median income among the neighbouring districts ✓ Mainly involved in low-paying occupations
Economic Activity ✓ Economic resource bases are forestry, pastoral farming and mining ✓ Business operations – major exporting sectors are farming and forestry products and soft drink, cordial and syrup whilst motor vehicles, insurance and advertising and marketing services are the major importing sectors
Quality of Life ✓ Separate houses are the main dwelling type, relatively low crime offences compared to the national average ✓ Cheapest cost of living among the neighbouring districts

The economic circumstances of South Waikato reveals the potential of business retention and development business ventures strategies as in Appendix 7. As the threat of businesses closing or relocating and lack of entrepreneurs have had heavy impacts on the South Waikato economy, the combination of these two strategies would be appropriate to resolute the region's economic problems. Currently, the District is facilitating neighbouring businesses and organisations getting together to identify the existing problems and potential solutions. By encouraging local businesses and residents to speak out their creative ideas and by providing technical assistance and/or loan packaging from the neighbourhood or local government, solutions which emerge are

more likely to be realistic and sustainable.

The South Waikato is not devoid of opportunities. There are many potential opportunities including:

- investment in value-added products in farming and forestry sector,
- Investment in education to enhance skills of employees and no participants and so retain population and enhance productivity.
- Investment in tourism to take advantage of the many people travelling to and form Rotorua, Taupo and Tauranga.
- Investment in transport hub facilities to take advantage of central location
- Investment in appropriate factory shop complexes to take advantage of central location and excess stock of buildings in Tokoroa
- Investment in engineering to export some of the existing product range and to enhance the product range beyond forestry and agriculture
- Investment in culture-oriented products to attract tourists or neighbouring residents to come and spend time in the region.

These opportunities and others are beneficial to the region as they will utilise the local human capital and enhance local investment. Other possibilities such as cooperative strategies among the neighbourhood industries or organising collective services (employment referrals, for example) and industrial real estate projects (including industrial parks) are ways to increase business activities and to bring economic development to the region.

Section 9 Conclusion

The South Waikato is a District characterised by significant resources but low employment prospects for its people. These prospects are diminished by the limited education of its population and the better opportunities in surrounding districts. If the South Waikato is to regain a growth trajectory initiatives will have to be taken. The District has opportunities to invest in value-added products in farming and forestry sector, in education, in tourism, in transport hub facilities, in appropriate factory shop complexes, in engineering and in culture-oriented products. If these opportunities or alternatives are not taken the District will continue to lose jobs and people.

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Appendix 1

Age/Sex Structure – 2001 Census

Table 1.1 Age Structure 2001

Area	South Waikato District	Hamilton City	Taupo District	Tauranga District	South Waikato District	Hamilton City	Taupo District	Tauranga District
0-4 Years	2,163	8,730	2,478	6,387	9.2%	7.6%	7.9%	7.0%
5-9 Years	2,358	8,568	2,667	6,597	10.0%	7.5%	8.5%	7.3%
10-14 Years	2,229	8,673	2,553	6,714	9.5%	7.5%	8.1%	7.4%
15-19 Years	1,629	10,104	2,052	5,901	6.9%	8.8%	6.5%	6.5%
20-24 Years	1,224	10,941	1,656	4,500	5.2%	9.5%	5.3%	5.0%
25-29 Years	1,446	8,976	1,956	5,349	6.2%	7.8%	6.2%	5.9%
30-34 Years	1,704	8,721	2,331	6,237	7.3%	7.6%	7.4%	6.9%
35-39 Years	1,794	8,262	2,451	6,699	7.6%	7.2%	7.8%	7.4%
40-44 Years	1,698	8,034	2,361	6,516	7.2%	7.0%	7.5%	7.2%
45-49 Years	1,506	7,215	2,082	5,937	6.4%	6.3%	6.6%	6.5%
50-54 Years	1,314	6,561	1,968	5,553	5.6%	5.7%	6.2%	6.1%
55-59 Years	1,110	4,851	1,641	4,632	4.7%	4.2%	5.2%	5.1%
60-64 Years	1,002	3,744	1,485	4,227	4.3%	3.3%	4.7%	4.6%
65-69 Years	822	3,138	1,266	4,026	3.5%	2.7%	4.0%	4.4%
70-74 Years	660	3,039	1,065	4,191	2.8%	2.6%	3.4%	4.6%
75-79 Years	441	2,424	750	3,591	1.9%	2.1%	2.4%	4.0%
80-84 Years	240	1,644	453	2,238	1.0%	1.4%	1.4%	2.5%
85 Years and Over	126	1,290	312	1,617	0.5%	1.1%	1.0%	1.8%
Total	23,472	114,921	31,521	90,906	100.0%	100.0%	100.0%	100.0%

Source: Statistics New Zealand

Table 1.2 Maori Age Structure 2001

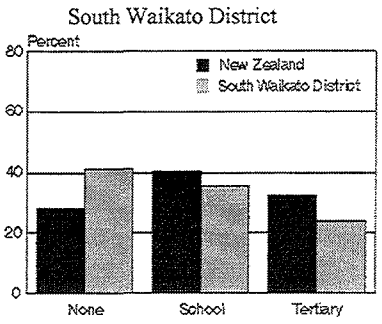
Area	South Waikato District	Hamilton City	Taupo District	Tauranga District	South Waikato District	Hamilton City	Taupo District	Tauranga District
0-4 Years	984	2,847	1,077	1,932	14.4%	13.3%	12.3%	13.7%
5-9 Years	957	2,544	1,140	1,803	14.0%	11.9%	13.0%	12.8%
10-14 Years	864	2,400	1,023	1,686	12.6%	11.2%	11.7%	11.9%
15-19 Years	615	2,256	816	1,356	9.0%	10.6%	9.3%	9.6%
20-24 Years	498	2,376	612	1,080	7.3%	11.1%	7.0%	7.7%
25-29 Years	474	1,884	600	1,032	6.9%	8.8%	6.9%	7.3%
30-34 Years	483	1,623	663	1,041	7.1%	7.6%	7.6%	7.4%
35-39 Years	489	1,407	627	1,044	7.1%	6.6%	7.2%	7.4%
40-44 Years	402	1,248	591	882	5.9%	5.8%	6.8%	6.3%
45-49 Years	327	900	402	699	4.8%	4.2%	4.6%	5.0%
50-54 Years	231	648	327	486	3.4%	3.0%	3.7%	3.4%
55-59 Years	177	456	258	327	2.6%	2.1%	2.9%	2.3%
60-64 Years	150	309	261	291	2.2%	1.4%	3.0%	2.1%
65-69 Years	105	198	177	207	1.5%	0.9%	2.0%	1.5%
70-74 Years	63	138	99	120	0.9%	0.6%	1.1%	0.9%
75-79 Years	21	72	57	78	0.3%	0.3%	0.7%	0.6%
80-84 Years	9	30	15	36	0.1%	0.1%	0.2%	0.3%
85 Years and Over	3	15	12	12	0.0%	0.1%	0.1%	0.1%
Total	6,849	21,354	8,754	14,112	100.0%	100.0%	100.0%	100.0%

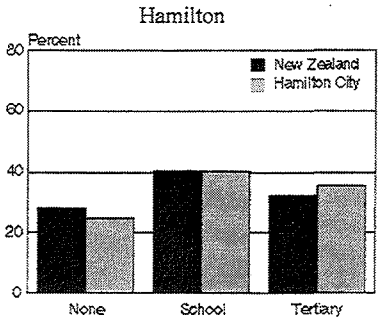
Source: Statistics New Zealand

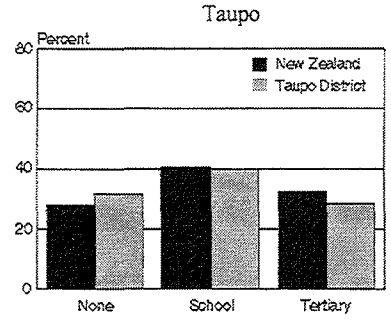
Source: Statistics New Zealand

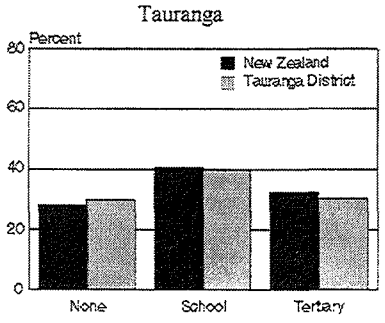
Appendix 3

Highest qualification – 2001 Census





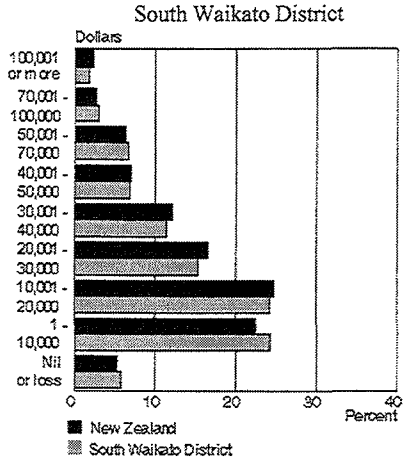


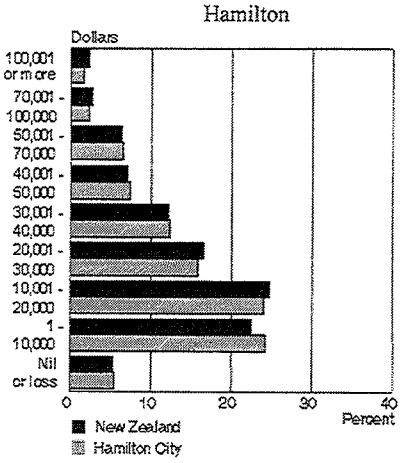


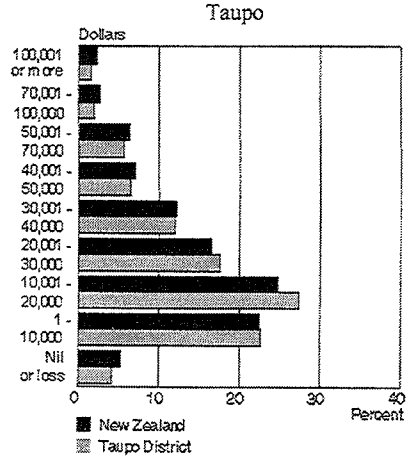
Source: Statistics New Zeland

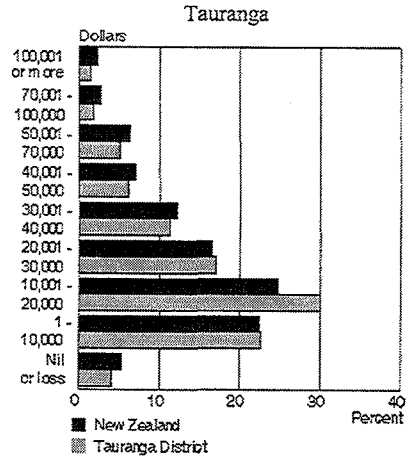
Appendix 4

Income – 2001 Census









Source: Statistics New Zealand

Table 4.1 Median Income for each District – 1996 and 2001 Censuses

	South Waikato District	Hamilton District	Taupo District	Tauranga District
2001	$17,600	$17,900	$17,900	$16,800
1996	$14,802	$15,188	$15,339	$14,530

Source: Statistics New Zealand

Table 4.2 Sources of Income(1) 2001
for Usually Resident Population Aged 15 Years and Over

					Percentage of Sources of Income			
	South Waikato District	Hamilton City	Taupo District	Tauranga District	South Waikato District	Hamilton City	Taupo District	Tauranga District
Wages, salary, commissions, bonuses etc paid by employer	8,358	51,525	11,874	34,674	50.4%	60.7%	54.5%	51.6%
Self-employment or business	2,415	10,224	4,134	10,800	14.6%	12.0%	19.0%	16.1%
Interest, dividends, rent, other investments	3,078	20,928	5,193	19,647	18.6%	24.7%	23.8%	29.2%
Regular payments from ACC or a private work accident insurer	318	1,338	453	1,182	1.9%	1.6%	2.1%	1.8%
NZ superannuation/veterans pension	2,208	10,851	3,705	15,129	13.3%	12.8%	17.0%	22.5%
Other superannuation, pension, annuities (other than NZ superannuation, veterans pension or war pension	342	2,739	762	3,015	2.1%	3.2%	3.5%	4.5%
Community wage job seeker	1,218	7,761	1,509	4,908	7.4%	9.1%	6.9%	7.3%
Community wage-sickness benefit	369	1,602	459	1,314	2.2%	1.9%	2.1%	2.0%
Domestic purposes benefit	1,074	3,987	1,086	3,111	6.5%	4.7%	5.0%	4.6%
Invalids benefit	372	2,106	459	1,608	2.2%	2.5%	2.1%	2.4%
Student allowance	201	4,773	288	1,488	1.2%	5.6%	1.3%	2.2%
Other government funded benefits, government income support payments, or war pensions	507	3,588	864	3,021	3.1%	4.2%	4.0%	4.5%
Other sources of income, including support payments from people living in other households	207	2,376	315	1,101	1.2%	2.8%	1.4%	1.6%
No sources of income	1,041	4,806	975	2,793	6.3%	5.7%	4.5%	4.2%
Total people	16,569	84,867	21,789	67,224	100.0%	100.0%	100.0%	100.0%

(1) Includes all of the people who stated each source of personal income, whether as their
a person reported more than one source of personal income, they have been counted in

Source: Statistics New Zealand

Appendix 5

Table 5.1 Occupation (Major Group) 2001
for Employed Usually Resident Population Aged 15 Years and Over

Area	Occupation (Major Group)						Occupation (Major Group)			
	Legislators, Administrators and Managers	Professionals	Technicians and Associate Professionals	Clerks	Service and Sales Workers	Agriculture and Fishery Workers	Trades Workers	Plant and Machine Operators and Assemblers	Elementary Occupations	Not Elsewh Include
South Waikato District	8.3%	9.2%	6.1%	9.0%	11.7%	18.5%	8.1%	14.6%	8.3%	6
Hamilton City	12.0%	16.7%	12.7%	14.2%	15.1%	2.4%	8.8%	7.4%	5.9%	4
Taupo District	13.4%	9.5%	8.0%	8.9%	18.8%	11.2%	8.7%	8.8%	6.6%	6
Tauranga District	12.9%	12.2%	10.8%	12.3%	16.0%	4.2%	11.4%	8.2%	7.1%	4

Source: Statistics New Zealand

Table 5.2 Industry (Major Division) 2001
for Employed Usually Resident Population Aged 15 Years and Over

Area	Industry (Division)									Industry
	Agriculture, Forestry and Fishing	Mining	Manufacturi ng	Electricity, Gas and Water Supply	Constructi on	Wholesale Trade	Retail Trade	Accommodati on, Cafes and Restaurants	Transport and Storage	Communicat ion Services
South Waikato District	21.1%	0.1%	22.5%	0.2%	4.1%	1.4%	11.8%	3.3%	3.7%	0.6%
Hamilton City	2.4%	0.1%	12.5%	0.7%	6.4%	5.9%	13.5%	4.6%	2.6%	1.7%
Taupo District	12.4%	0.1%	8.4%	1.0%	7.0%	2.9%	14.5%	11.7%	3.8%	0.7%
Tauranga District	3.8%	0.1%	12.9%	0.2%	9.1%	5.9%	15.0%	4.4%	5.0%	1.1%

Area	continues...Industry (Major Division)							
	Finance and Insurance	Property and Business Services	Government Administration and Defence	Education	Health and Community Services	Cultural and Recreational Services	Personal and other Services	Not Elsewhere Included(2)
South Waikato District	22.5%	0.2%	4.1%	1.4%	11.8%	3.3%	3.7%	0.6%
Hamilton City	12.5%	0.7%	6.4%	5.9%	13.5%	4.6%	2.6%	1.7%
Taupo District	8.4%	1.0%	7.0%	2.9%	14.5%	11.7%	3.8%	0.7%
Tauranga District	12.9%	0.2%	9.1%	5.9%	15.0%	4.4%	5.0%	1.1%

Source: Statistiscs New Zealand Census Data

Table 5.3 Average Personal Per Hour Earning 1989/90-2000/01
for Usually Resident Population Aged 15 Years and Over

Yearly	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01
				$/hour						$/hour		
Forestry & Mining	14.01	14.6	15.51	15.2	14.89	15.44	16.09	16.88	17.89	18.59	17.56	18.18
Manufacturing	12.59	13.21	13.6	13.71	13.81	14.12	14.61	15.14	15.63	16.15	16.6	17.14
Electricity, Gas & Water	14.76	15.44	15.8	15.73	16.12	17.05	17.77	18.78	20.12	21.17	23.1	24.32
Construction	11.89	12.5	12.72	12.65	12.81	13.19	13.66	14.17	14.63	15.15	15.77	16.29
Wholesale Trade	13.94	14.79	15.29	15.62	15.87	16.16	16.58	17.3	17.87	18.41	18.76	19.1
Retail Trade	9.93	10.43	10.67	10.7	10.78	10.97	11.29	11.56	11.98	12.09	12.27	12.55
Accommodation & Restaurants	10.31	10.8	10.93	10.91	10.99	11.12	11.32	11.71	11.98	12.04	11.97	12.34
Transport, Storage & Communicn	14.13	15.31	15.82	15.86	15.95	16.01	16.3	16.92	17.3	17.45	17.61	17.86
Finance & Insurance	15.07	16.08	16.84	17.62	18.18	18.97	20.25	21.14	21.86	22.9	23.34	24.35
Property & Business Services	15.66	16.11	16.41	16.75	17.02	17.41	17.93	18.81	19.33	20.01	20.3	20.84
Govt Administration & Defence	15.83	16.68	17.21	17.41	17.54	17.91	18.42	19.11	19.52	20.7	21.55	22.38
Education	15.84	16.38	16.69	16.61	16.46	16.58	16.98	17.96	18.71	19.58	20.43	21.01
Health & Community Services	14.04	14.66	15.13	15.29	15.37	15.61	16.25	16.81	17.38	17.66	17.9	18.14
Cultural & Recreation Services	13.78	14.53	15.2	15.59	15.79	16.26	16.28	16.73	16.95	17.79	18.51	19.05
Personal & Other Services	14.94	15.35	15.76	15.98	15.88	16.07	16.19	16.63	16.84	16.67	17.04	17.83
All Industries	13.5	14.2	14.62	14.74	14.83	15.11	15.57	16.18	16.68	17.14	17.51	17.98

Source: Statistics New Zealand Census

Table 5.4 Percenage Change per Personal Hour Earning 1989/90-2000/01
for Usually Resident Population Aged 15 Years and Over

	1989/90-2000/01	Order
Forestry & Mining	29.76%	9
Manufacturing	36.14%	6
Electricity, Gas & Water	64.77%	1
Construction	37.01%	4
Wholesale Trade	37.02%	4
Retail Trade	26.38%	11
Accommodation & Restaurants	19.69%	13
Transport, Storage & Communicn	26.40%	13
Finance & Insurance	61.58%	2
Property & Business Services	33.08%	7
Govt Administration & Defence	41.38%	3
Education	32.64%	8
Health & Community Services	29.20%	12
Cultural & Recreation Services	38.24%	9
Personal & Other Services	19.34%	15

source: Statistics New Zealand (ANZSIC Group)

Appendix 6

Access to Telecommunication Systems - 2001 Census

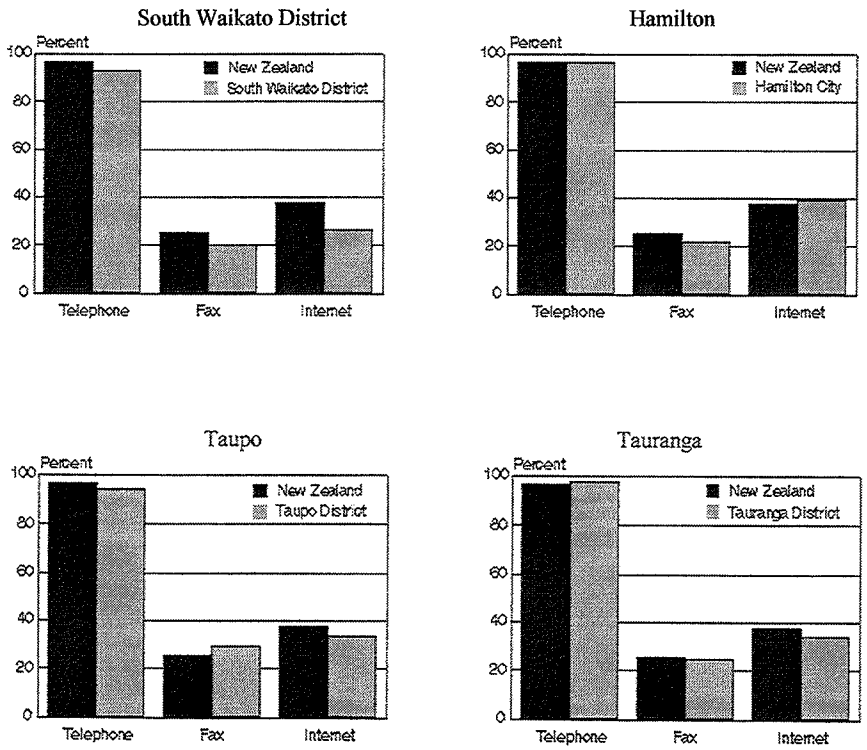


Table 6.1 Weekly Rent 2001
for Private Rented Dwellings

Area	Weekly Rent Paid by Households											Weekly Rent Paid by Households
	Under $50	$50 - $79	$80 - $99	$100 - $124	$125 - $149	$150 - $174	$175 - $199	$200 - $249	$250 - $299	$300 - $349	$350 and Over	Not Elsewhere Included[1]
South Waikato District	5.1%	12.1%	9.7%	26.7%	31.4%	7.1%	0.8%	0.6%	0.3%	0.2%	0.6%	5.4%
Hamilton City	2.9%	9.5%	3.5%	9.9%	8.7%	11.2%	14.3%	24.7%	7.3%	2.4%	1.5%	4.0%
Taupo District	3.7%	10.3%	5.1%	14.3%	12.9%	16.1%	16.0%	12.7%	2.3%	0.6%	1.1%	5.0%
Tauranga District	3.1%	6.4%	2.9%	6.3%	5.6%	16.9%	20.3%	27.4%	4.6%	1.5%	1.1%	4.0%

Source: Statistics New Zealand

Table 6.2 Number of Motor Vehicles 2001
for households in private dwellings

Area	Number of Motor Vehicles					
	No Motor Vehicle	One Motor Vehicle	Two Motor Vehicles	Three or More Motor Vehicles	Not Stated	Total
South Waikato District	10.6%	42.6%	31.8%	10.1%	4.9%	100.0%
Hamilton City	10.2%	41.2%	33.6%	12.0%	3.1%	100.0%
Taupo District	8.3%	38.6%	35.5%	12.1%	5.5%	100.0%
Tauranga District	7.9%	42.7%	35.3%	10.4%	3.8%	100.0%

Source: Statistics New Zealand

Table 6.3 Number of Access to a Telephone 2001

	South Waikato District	Hamilton District	Taupo District	Tauranga District
2001	7.1%	4.0%	6.1%	2.9%
1996	10.6%	4.6%	10.1%	4.3%

Source: Statistics New Zealand

Table 6.4 Dwelling Type 2001
for Dwellings (private nand non-private)

Area	Private Dwelling				Private Dwelling		Non-Private Dwelling
	Separate House	Two Flats/Units/ Townhouses/ Apartments/Houses Joined Together	Three or More Flats/ Units/Townhouses/ Apartments/Houses Joined Together	Other[1]	Temporary Private Dwelling	Total, Private Dwellings	
South Waikato District	84.9%	4.4%	3.9%	6.4%	0.1%	99.6%	0.4%
Hamilton City	77.9%	9.2%	7.0%	5.3%	0.1%	99.6%	0.4%
Taupo District	79.2%	6.5%	4.1%	8.2%	0.5%	98.5%	1.5%
Tauranga District	75.2%	11.3%	6.6%	5.9%	0.5%	99.5%	0.5%

Source: Statistics New Zealand Census

Table 6.5 Tenure of Household 2001
for households in private occupied dwellings

Area	Tenure of Household				Tenure of Household				
	Dwelling Owned or Partly Owned by Usual Resident(s), Who Make Mortgage Payments	Dwelling Owned or Partly Owned by Usual Resident(s), Who Do Not Make Mortgage Payments	Dwelling Owned or Partly Owned by Usual Resident(s), Mortgage Arrangements Not Further Defined	Total, Owned	Dwelling Not Owned by Usual Resident(s), Who Make Rent Payments	Dwelling Not Owned by Usual Resident(s), Who Do Not Make Rent Payments	Dwelling Not Owned by Usual Resident(s), Rental Arrangements Not Further Defined	Total, Not Owned	Not Elsewhere Included[1]
South Waikato District	31.4%	32.3%	1.0%	64.8%	24.8%	3.4%	1.2%	29.4%	5.8%
Hamilton City	32.8%	25.4%	0.7%	58.9%	34.9%	1.9%	0.7%	37.6%	3.5%
Taupo District	29.2%	30.9%	0.9%	61.0%	27.5%	4.1%	1.2%	32.8%	6.2%
Tauranga District	29.6%	34.1%	0.8%	64.6%	26.5%	3.5%	1.1%	31.1%	4.4%

Source: Statistics New Zealand

Table 6.6 Summary of National Recorded Crime offences* per 10,000 Population
Years ended 30 June 1998/99-2000/01

District	Recorded Offences per 10,000 Population[1]		
	1998/99	1999/2000	2000/2001
Auckland City	1,597.7	1,575.6	1,522.2
Waikato	1,407.6	1,224.5	1,132.5
New Zealand	**1,195.5**	**1,128.6**	**1,102.3**

[1] *District populations estimated from average annual variation between 1986-91 and 1991-1996*
*Total offences comprise the 7 offence categories of Violence, Sexual, Drugs and Anti-Social, Dishonesty, Property Damage, Property Abuse and Administration.

Table 6.7 Summary of Rate of National Recorded Crime offences* per 10,000 Population
Years ended 30 June 1998/99-2000/01

District	Recorded Offences per 10,000 Population[1]		
	1998/19991999/2000	1999/20002000/2001	
Auckland City	-1.38%	-3.39%	
Waikato	-13.01%	-7.52%	
New Zealand	-5.59%	-2.33%	

Source: New Zealand Police Crime Statistics

Appendix 7 Types of Economic Development Strategy

Economic Development Strategy		
Business retention	**Objective** Stabilising the existing businesses and industrial districts	**Implication** Identifying business problems; organising business leaders; providing technical assistance and loan packaging; organising collective services and industrial real estate projects; advocates for public policies
	Criteria Experiencing business disinvestments, loosing competitive advantage	**Example**
Commercial revitalisation	**Objective** Collaboration of neighbourhood businesses to represent a common interest that no single business can accomplish	**Implication** Sponsoring marketing campaigns; commercial strip management; business attraction and retention services and targeted real estate development
	Criteria Commercial districts need a more content business environment to promote for economic growth	**Example**
Development of business ventures	**Objective** Strengthening neighbourhood economies by hiring locally and spending locally	**Implication** Neighbourhood organisation initiate/facilitate new business ventures such as construction companies, cooperatives, property management firms and recycling businesses
	Criteria Lack of indigenous entrepreneurs and neighbourhood locations are unattractive to market-driven actors	**Example**
Entrepreneurship	**Objective** Establishing home-grown entrepreneurs to enhance neighbourhood ownership, employment and development	**Implication** Neighbourhood organisations train and nurture local entrepreneurs by making the most of human resources that have been underused locally
	Criteria Lack of entrepreneurialism	**Example**
Neighbourhood capital accumulation	**Objective** Gaining neighbourhood ownership and taking control over land, businesses, investment, and financial capital	**Implication** Establishing new institutions such as community development corporation, land trusts, community development credit unions, or development local funds that invest resources in neighbourhood development ventures
	Criteria Under-used neighobuhrood resources and under invested opportunities	**Example**
Employment, training and placement	**Objective** Providing basic skills, employment training, transportation, job readiness, anti-discrimination efforts, job linkages, and ongoing on-the-job supports	**Implication** Investing in the human capital of neighbourhoods and making an effort to connect residents with jobs
	Criteria Under-used human resources and neighbourhood economic assets	**Example**

Labour-based development	**Objective** Attracting higher wage jobs to neighbourhoods through labour force training and business support services	**Implication** Identifying the employment skills of neighbourhood residents, especially those unemployed and recently displaced workers and helping them to seek industries that require similar occupational skills and also to attract specific industries to the neighbourhood
	Criteria Neighbourhood business sectors have potential for growth and clustering	**Example**
Community organising/ planning	**Objective** Neighbourhood communities take control of their own flow of resources and opportunities	**Implication** Neighbourhoods get together in citywide coalitions to maximise their strength and to address systemic biases in the decision-making processes and allocations of public and private resources
	Criteria Need for change in the neighbourhoods	**Example**

Source, Wiewel, Teitz and Giloth, 1993

Agricultural and Forestry Forecasting Activities within MAF Policy[1]

Rod Forbes, MAF Policy, Wellington

SUMMARY

MAF Policy undertakes the forecasting of production, prices and exports for key agricultural and forestry products at the aggregate level. This paper explains why forecasting is done and its relationship to other MAF Policy activities, methodologies used using lamb price as an example, and how forecasts have compared to actual outcomes in recent years. The main reason for medium-term forecasting is independence from industry. Forecasts from 1996 have performed reasonably well, except for poor systematic bias, due to the understating of commodity prices in 2001 and the overstating of exchange rate assumptions.

Key words: forecast performance, prices, production and exports

INTRODUCTION

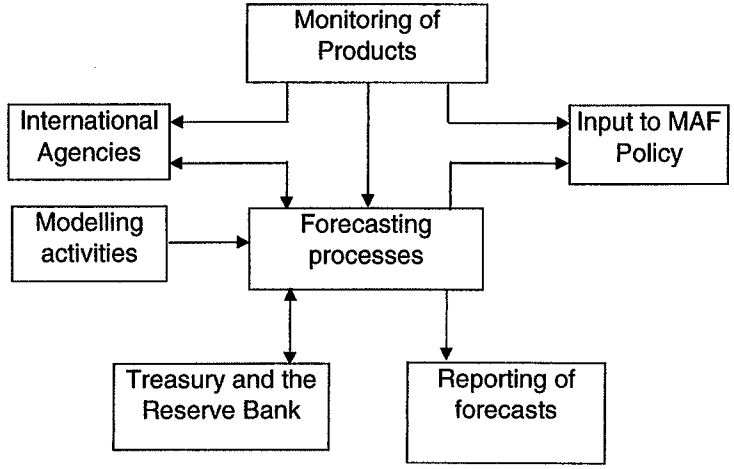
The land-based sectors and downstream processing activities contribute around 66% of New Zealand's exports, and contribute (depending on how one measures it) around 20% of GDP. Quarterly production GDP measured by Statistics New Zealand, is particularly influenced by volatility from the agriculture sector – mainly through negative and positive climate shocks.

The rationale for MAF Policy's involvement in forecasting is rooted in history and continues to be valid today. The programme area is Current Economic Situation (CES) activities and encompasses a number of areas. These areas are monitoring for international and domestic prices, industry issues, production and exports of key products; maintenance and development of models; forecasting of agriculture and forestry; reporting of forecasts; providing input to other policy activities as required; providing data to OECD and FAO and support to international policy group. All of these activities are inter-related as shown in the diagram, but this paper focuses on the processes involved in forecasting.

Forecasting activities revolve around the requirements of The Treasury, under the Fiscal Responsibility Act, for the preparation of Economic and Fiscal Updates for the Budget and December rounds. A third round for Treasury is required in election year for pre-election briefing. MAF Policy provides inputs for agricultural and forestry exports, and the contribution of the agriculture sector to GDP. While this is an important function, forecasting would still be undertaken even if Treasury no longer required our input.

Forecasting in relation to key products is undertaken by nine staff involving 1.12 full time equivalents per annum. In addition, information on current season production and related issues can be obtained from regionally based staff and policy agents. MAF Policy has considerable institutional memory with respect to monitoring and forecasting. Key export products include dairy products, sheep meat, beef, venison, wool, co-products of livestock slaughter, kiwifruit, apples, wine and forestry products. However, a comprehensive picture of pastoral and horticultural exports is built up. Because of the importance to domestic consumption, forecasts of arable products, pig meat and poultry products are also undertaken. Treasury requires a three-year outlook, but OECD requires a six-year outlook. Treasury requires forecasts in terms of March years, while historically we have provided OECD with data mainly on industry standard years.

Relational chart of CES activities



WHY IS MAF POLICY INVOLVED IN FORECASTING?

MAF Policy's involvement in forecasting activities has its roots in historical decisions[2]. Monitoring of production and prices has always been a core activity of MAF and its organisational predecessors. The former New Zealand Forest Service compiled forestry statistics from 1951. From an agricultural perspective, focus was then placed on the current seasons' opening and closing inventories, and expected production and exports. The then Department of Agriculture initiated the first publication of a comprehensive economic perspective of the agricultural sector with the "Economic Position of the Farming Industry" in May 1970 under the auspices of the Agricultural Production Council. A similar publication followed in April 1971. Forecasts were restricted to making estimates for the current year. MAF publications did not provide aggregate forecasts until 1987 when the "Situation and Outlook for New Zealand Agriculture" series began. However, the "State of Agriculture 1985/86" publication did provide, for the first time, farm gate budget forecasts for the subsequent year.

There are a number of key events in the path to the standard of forecasting evident today.

[1] Contribution paper to the New Zealand Agricultural and Resource Economics Society' annual conference, 5-6 July 2002. The author is grateful to colleagues Tony Wharton and David Lillis for comments made on a draft version of this paper.

[2] I am grateful for information gleaned from conversations with a number of people, including Robin Johnson, John Askwith, Richard Wallace and Jagdish Prasad

- In 1972, Dr Robin Johnson (then Deputy Director Economics Division) initiated a change to a more forward-looking focus on the next season's outcome and Treasury began to receive more detailed data on exports and contribution to GDP during the 1970's. At the request of Treasury, the concept of net taxable revenue as developed from Statistics Department data around the middle to latter part of that decade.
- Following the Labour Government's de-regulation policies from 1984 onwards, and a downturn in international prices in 1985/86, there were three drivers for MAF to initiate forecasting activities. Firstly, the senior management developed a strategic view that medium term forecasting capability, independent of industry organisations, was in the public interest. Secondly, there was pressure from New Zealand Trading Banks for MAF to provide independent forecasts. Thirdly, MAF senior management was considering the idea of holding annual outlook conferences similar to that of the then Australian Bureau of Agricultural Economics (now known as ABARE).
- The Monitoring and Market Analysis Group (MAMAG) was formed in mid 1986 and became part of the International Section in 1988. The focus was then on international outlook for prices and exports of key agricultural products. The work on inventory, production, and sector contribution to GDP continued with the Domestic Policy Group.
- The first comprehensive forecasts by MAF for Treasury were carried out for the 1989 Budget round. This arose from inconsistencies between MAF forecasts of production and Treasury's forecasts of exports. From the floating of exchange rates in 1985, Treasury had decided to do their own forecasts of agricultural exports. The Ministry of Forestry (MoF) also began to provide forecasts of forestry exports from 1989 onwards.
- From 1989, the Treasury tended to expand their requests for data to support the stories around agricultural export forecasts. The first set of agricultural forecasts for the OECD was provided in March 1990.
- With the merger of MoF and MAF in 1997, agricultural monitoring and forecasting activities were passed to the Policy Information and Regions Group (PI&R), along with forestry statistics and forecasting activities. At the same time the full responsibility for inventory and production in agriculture passed from the previous Domestic Policy Group to the PI&R.
- Around 1986, personal computers and Lotus spreadsheet software became available to analysts in MAF. This allowed paper-based systems to move to electronic analysis with its many advantages. From 1988, the purchase of Lotus 3 with its three-sheet file allowed rapid development of spreadsheets for monitoring and forecasting purposes. The twin developments of Windows technology and increasingly powerful spreadsheet technology (Excel) from the-mid 1990's allowed expanded and complex spreadsheet developments along with file linking.
- The Pastoral Supply Response Model was developed by February 1990, with the prior appointment of appropriately skilled staff. This model forecast livestock numbers and production for dairy, sheep and beef industries. This was the first econometric model to be based on dedicated software, in this case, Time Series Processing. Other model developments followed.

In 2001 as part of a capability review process in MAF Policy, a review of CES activities was undertaken. The review team included staff from the New Zealand Institute of Economic Research (NZIER) and Treasury. The NZIER evaluated approaches, methodologies and efficiencies. The review found that:

- Forecasting processes are robust; the analysts involved are competent; outputs are valued by key end users; and in-house forecasting should continue.
- Several areas for improvement were identified including: the need to update some economic models; reducing and simplifying a number of spreadsheets with complex linkages; better presentation and wider promotion of forecasting results; and to recognise the risks of the high-level of human capital vested in a small number of staff.

FORECASTING PROCESSES

Key products in the pastoral, horticultural and forestry industries are monitored in terms of international and domestic prices, production, imports, exports and industry issues. Statistical data from monitoring are recorded in spreadsheets and this provides the background for forecasting.

Forecasts are based on macroeconomic assumptions supplied by the Treasury – exchange rates, interest rates and inflation rates for the New Zealand economy over a three-year outlook period. International assumptions for growth, interest and inflation rates are those compiled by Consensus Forecasts of the UK.

Given these macroeconomic assumptions, the forecasting process used for the majority of products from the agricultural sector involves:

- Forecasting international product price trends using econometric and spreadsheet based models along with some industry consultation;
- Translating international product prices to the farm/orchard level;
- Forecasting the supply (production) response;
- Deriving export volumes and values from total production and price forecasts; and
- Deriving gross agricultural revenue and expenditure, and taxable income.

Forestry forecasts of international price trends rely on independent modelling frameworks and on consultation with key players in the forestry industry. The forecast volumes of forestry products are based on analysis of market information and industry consultation.

International prices measures for various products are the international spot prices for dairy products, US beef market, UK lamb market, European venison market, NZ wool auction, and NZ FOB for forestry products. Kiwifruit, apple and wine models are elasticity-based for target markets. The main factor determining forestry export prices, apart from the exchange rate assumptions, include growth rates in major overseas markets. Use is made of international forecasts by reputable agencies that are available for substitute or competitive products. Such organisations include Food and Agriculture Policy Research Institute (FAPRI), the USDA and the OECD. The link between international spot prices and payouts for milksolids is not straightforward. A major reason for this is that Fonterra Co-operative Group Ltd receives about one-third of its gross revenue from repatriated profits on subsidiary companies worldwide. Considerable degree of judgement is required.

PI&R has a commitment to on-going updating and development of models, but these activities tend to be crowded out by higher priorities – often unplanned and imposed.

However, reasonable progress is being made. The goal is to move slowly towards quarterly period models over the next two or three years. The first of these was the Wool Price Model developed under contract by the NZIER. Agresearch has also been contracted to evaluate some of the econometric models and make improvements, as appropriate. To date examples are supply response models of livestock inventory and kiwifruit yield.

As an example of product price forecasting, I will use lamb in relation to the March 2002 forecasting round. Two spreadsheet models are used, one for the international price derivation and the other for the derivation of the all grades average lamb schedule price in New Zealand. The structure of these spreadsheets is largely unchanged from the early 1990's. However, a revision to the system is planned for. The international price of lamb used is the London Central Markets price for PM grade carcass. Table 1 sets out lamb export volumes for the UK and all markets for main product classifications.

For the year ended 30 September 2001, lamb carcass exports to the UK were 10,941 tonnes, making up 14% (on a carcass weight equivalent basis) of lamb exports to that market, and 3% of lamb exports to all markets. Of the 10,941 tonnes of carcass lamb that went to the UK, 2,636 tonnes or 27% was PM grade (that is, under 1% of total lamb exports to all markets on a carcass weight equivalent basis). By comparison, in the year ended September 1997, 12,282 tonnes of PM grade went to the UK.

In spite of small and declining volumes compared to total New Zealand lamb exports in recent years, the UK market still provides a representative proxy for international lamb prices. Meat Industry Association data gathered from 1989 for selected New Zealand lamb product cif (in NZD) prices to the EU, correlates highly with PM grade carcass prices as follows: UK leg 82%, UK loin chops 81%, German YM carcass 82%, German saddle cut 84%, and French saddle cuts 77%.

Table 1: Lamb exports for year ended September 2001

	UK Tonnes	All Markets Tonnes
Carcasses	10,961	33,275
Bone-in cuts	44,389	226,763
Boneless cuts	9,775	38,761
Total (pw)	65,125	298,799
Total (cwe)	78,760	357,278

pw = product weight and cwe = carcass weight equivalent
Source: Meat NZ and MAF calculations for cwe

The main data source for UK prices of competitive meat products is the UK Meat and Livestock Commission. The latter publishes short-term quarterly forecasts of UK meat production, but not longer-term forecasts. The annual OECD Outlook publication provides medium to long term production and price projections for competitive meat products in OECD member countries, including the EU as a whole. These are based on their Aglink model. PI&R also have access to preliminary results during the year. The sheep meat module with respect to price is unreliable. MAF Policy currently has a contract with ABARE to develop a comprehensive sheep module for Aglink.

Regression equations are set up as annual periods. Firstly, the UK domestic lamb price is estimated as follows:

$$\ln(UKLPr) = 3.585 - 0.645 * \ln(M\&LPn) + 0.126 * \ln(Expts) + 0.531 * \ln(BFPr) + 0.384 * \ln(PKPr)$$
(4.9) (-5.0) (3.9) (6.3) (4.4)

Adjusted $R^2 = 0.97$ t-test results in brackets under regression coefficients

Secondly, the NZ wholesale lamb price is estimated as follows:

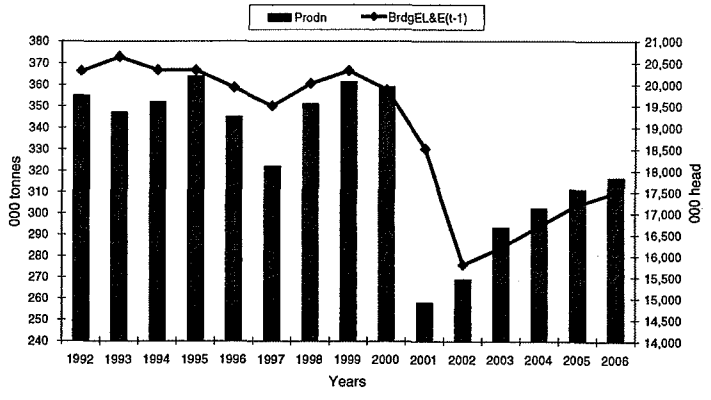
$$\ln(NZLPr) = 6.010 + 0.507 * \ln(UKLPr) - 0.799 * \ln(M\&LPn) + 0.086 * \ln(Expts)$$
(4.8) (6.7) (-3.8) (1.8)

Adjusted $R^2 = 0.89$

Where
Ln(UKLPr) = natural log of UK domestic lamb prices
Ln(M&LPn) = natural log of UK sheep meat production
ln(Expts) = natural log of UK sheep meat and meat equivalent of livesheep exports
ln(BFPr) = natural log of UK domestic beef prices
ln(PKPr) = natural log of UK domestic pork prices
ln(NZLPr) = natural log of NZ wholesale prices of PM grade lamb

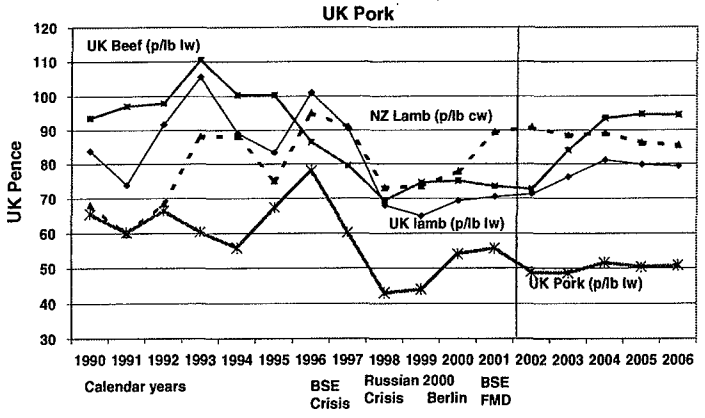
The most significant variable affecting lamb price is the UK sheep meat production. This was very evident during and after the Foot-and-Mouth Disease outbreak in 2001. Sheep inventory numbers fell 13% as a consequence of the government measures implemented to eradicate the disease. Chart 1 shows the trends in UK breeding flock (ewes and hoggets) and sheep meat production.

Chart 1: UK Sheepmeat Production and Opening Breeding Flock Numbers



The past prices and my projections of competitive meats in the UK are shown in Chart 2.

Chart 2: Nominal Price Trends in NZ Lamb, UK Lamb, UK Beef and UK Pork



The next step is to convert the international price into a New Zealand export price at FOB and then to a producer price. This involves an adjustment for exchange rate assumptions, and weighting for EU and non EU export prices at FOB. The New Zealand producer price used is the all grades average lamb price series derived by The Economic Service. Forecasts and projections for slipe wool and pelt are also carried out and added to the prices for carcasses, which then gives the producer price for lamb.

Once pastoral product prices have been forecast, an intertemporal supply response is undertaken. The Pastoral Supply Response Model has not been performing particularly well, partly because of the absence of an annual sequence of inventory livestock numbers since 1996. The June 2002 agricultural census will be an important stake-in-the-ground for livestock numbers in New Zealand. In future, a census will be conducted every five years, with surveys in all of the intervening years.

Dairy and deer numbers are independently forecast, along with assumptions about forestry expansion. The Livestock Improvement Corporation has been contracted in recent years to provide a current estimate and their view of projected number of dairy cows in milk. Deer numbers forecasts come from an integrated demand and supply econometric model. While the pastoral model is actually ran, the results are adjusted for dairy and deer numbers, and stock unit losses due to forestry expansion.

Production volumes for main products are forecast from inventory levels and assumptions about progeny births and productivity gains. Over the short term, climate is a source of production variation, and the explanatory variable used is days of soil moisture deficit supplied by the National Institute of Water and Atmospheric Research (NIWA). In additions to monthly data purchased, PI&R fund three climate briefings per year, where NIWA staff provide short term climate outlooks at a public meeting in Wellington, with participants from other Government ministries, the finance sector, and agribusiness and industry organisations. A summary is made available on MAF's Internet site.

Once production data is compiled, estimates of domestic consumption are netted off to give export volumes. The value of production at farm gate is also used to estimate the contribution to GDP for the agriculture sector.

HOW HAS MAF POLICY PERFORMED?

A major review of MAF Policy's forecasting performance was contracted to Nimmo-Bell and Company Ltd in 1996, who evaluated forecast data from the annual "Situation and Outlook for Agriculture" publications and, where applicable, compared these with forecasts made by other organisations. Their report concluded that:

- "the overall standard of MAF forecasting was high;
- MAF forecasts compared favourably with other forecasters;
- MAF's main competitive advantage was its provision of regular, comprehensive and internally consistent sets of forecasts which are seen as independent, objective and free of interest group bias;
- the depth and broad range of products covered by MAF was not available in the private sector (at that time); and
- there was a demand for MAF to provide six monthly updates of forecasts."

An analysis of some of MAF Policy's forecast data is presented below, along with graphs of forecast versus actual outcomes in the appendix. This analysis compares forecasts made at least one year (t+1) from the date of the forecasting round for a full year's result. There are sets of forecasting rounds relating to the same actual outcome as follows:

- Forecasting rounds October 1996 and March 1997 relate to outcomes in 1998,
- rounds October 1997 and March 1998 relate to outcomes in 1999,
- rounds October 1998 and March 1999 relate to outcomes in 2000,
- rounds August 1999, October 1999 and March 2000 relate to outcomes in 2001, and
- rounds October 2000 and March 2001 relate to outcomes in 2002.

The variables analysed are:

- USD:NZD exchange rate for March years (USNZER)
- UKP:NZD exchange rate for March years (UKNZER)
- Milksolids average payout for May years (MSPR)
- All grades average lamb schedule price for June years (LBPR)
- Manufacturing cow (145.5 – 170 kg) schedule price for June years (BFPR)
- Dairy volume overseas trade index (OTI) for March years (DYXVO)
- Dairy export value for March years (DYXVA)
- Lamb export volume for March years (LBXVO)
- Beef export volume for March years (BFXVO)
- Meat export value for March years (MTXVA)
- Gross agricultural revenue for March years (GAREV)
- Agriculture sector income for March years (ASINC)

The measures of accuracy used are those of the Nimmo-Bell study. These are:

- Forecast accuracy – the mean absolute percentage error over the time series of forecasting rounds, converted to a positive value by subtracting from 100% (the perfect fit).
- Range - the lowest and highest score of forecast accuracy for any one round.
- Theil's Inequality coefficient[3] which measures the deviation of the forecast series from its actual data.
- Systematic bias[4] which measures the extent to which average forecast and actual series deviate from each other. This measure is derived from Theil's Inequality coefficient.
- Turning points - the number of times the forecast moves in the direction of the actual. Because a set of forecasts compares with the same actual outcome, a turning point is referenced to the actual of the previous set of forecasts.

The performance results for the selected variables are set out in Table 2 (see appendix for graphs). The main findings are:

- The average accuracy was reasonably good with values from 83% for agriculture sector income to 95% for lamb export volume, with six scoring from 90% and 95%, and six scoring from 83% and 89%.
- The accuracy range was lowest for agriculture sector income at 64% in the August 1999 round and highest equal at 100% for lamb export volume in the March 2000 round and for gross agricultural revenue in the October 1997 round.
- The low range accuracy had six scoring from 64% and 79% and six scoring from 82% to 90%.
- The high range accuracy had scoring from 97% and 100%.
- The results for Theil's Inequality coefficient were encouraging with values from 0.03 for lamb export volume and 0.13 for agricultural sector income with seven from 0.03 to 0.08 and five from 0.10 to 0.13.
- However, systematic bias was poor overall. For volume forecasts, the results were 0.02 for lamb export volume, 0.30 for dairy export volume and 0.52 for beef export volume. For price and value variables, the best was 0.36 for meat export value and the worst was 0.81 for beef schedule price.
- The percentage of forecasts with correct turning points ranged from 100% for agricultural sector income down to 33% for lamb export volume, with the remainder from 56% to 86%.

While Treasury provides us with exchange rate assumptions for each forecasting round, it is important to note that exchange rates cannot be forecast. With the exception of the October 1998 round, all exchange rate assumptions have been higher than the actual outcomes. A stronger currency assumption compared to actual outcome will contribute to an understating of producer price and export value forecasts compared to their actual outcomes.

In addition to exchange rate influences on the performance of price and value variables, the strong rise in international dairy product and lamb prices in 2001 was not anticipated 12 to 18 months beforehand.

[3] Theil's Inequality coefficient, $U = \{1/T * \Sigma(Yf_i - Ya_i)^2]^{0.5} / \{[1/T * \Sigma(Yf_i)^2]^{0.5} + [1/T * \Sigma(Ya_i)^2]^{0.5}\}$ where Yf_i is forecast, Ya_i is the actual for forecasting rounds from t=1, 2, … ,T

[4] Systematic bias $U^m = (Yf\ average - Ya\ average)^2 / [1/T * \Sigma(Yf_i - Ya_i)^2]$

Table 2: Results of performance of forecasting rounds for selected variables

	Accuracy			Theil's	Syst	Turning points		
	Average	Low	High	Inequal.	Bias	Cor.	Max.	%
USNZER	87%	77%	97%	0.07	0.74	6	9	67%
UKNZER	90%	87%	98%	0.06	0.57	5	9	56%
MSPR	89%	70%	98%	0.10	0.44	7	9	78%
LMPR	86%	71%	97%	0.11	0.54	4	7	57%
BFPR	87%	82%	98%	0.08	0.81	6	7	86%
DYXVO	93%	87%	98%	0.04	0.30	7	9	78%
DYXVA	86%	71%	97%	0.10	0.38	6	9	67%
LBXVO	95%	90%	100%	0.03	0.02	3	9	33%
BFXVO	92%	84%	98%	0.04	0.52	6	9	67%
MTXVA	90%	83%	98%	0.06	0.36	7	9	78%
GAREV	91%	79%	100%	0.07	0.51	5	7	71%
ASINC	83%	64%	99%	0.13	0.56	7	7	100%
Nimmo-Bell Study results								
MSPR	83%			0.10	0.02			50%
LMPR	86%			0.09	0.23			88%
BFPR	90%			0.06	0.06			90%
GAREV	93%			0.05	0.04			75%

Also included in Table 2 are selected results from Nimmo-Bell (1996) for comparison. These show broadly consistent results for accuracy and Theil's Inequality coefficient and turning points, but not for bias. The Nimmo-Bell results covered nine forecasting events from 1987 to 1995.

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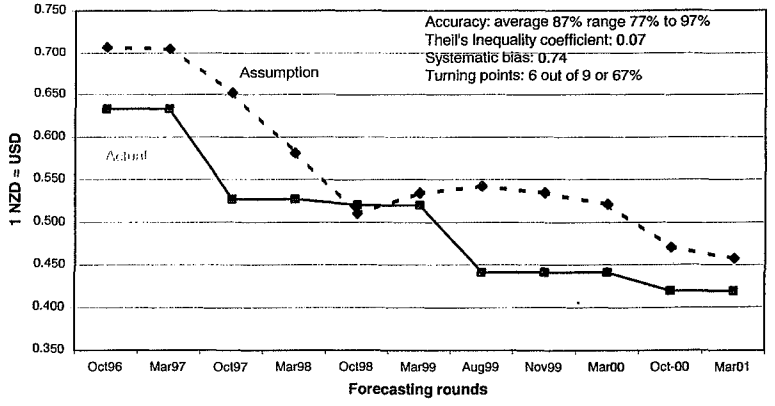
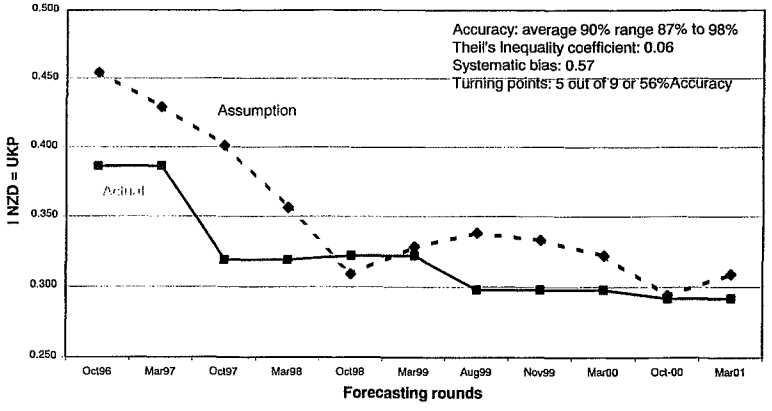
APPENDIX

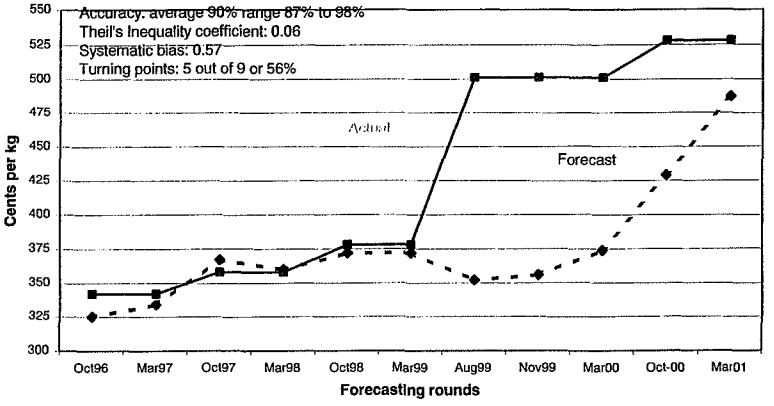
USD:NZD rate assumption vs actual for March year t+1



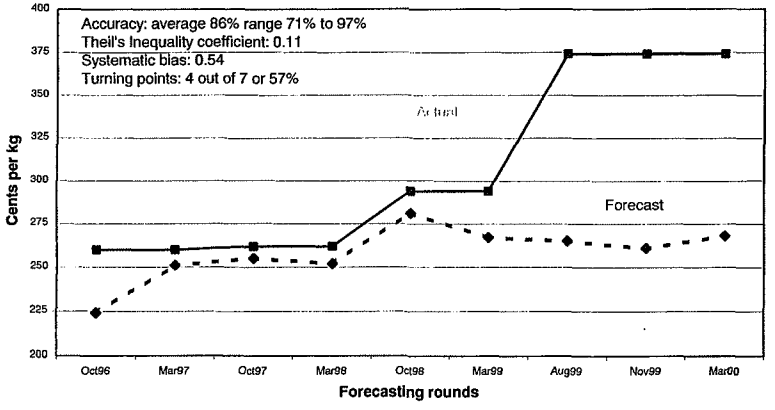
UKP:NZD exchange rate assumption vs actual for March year t+1



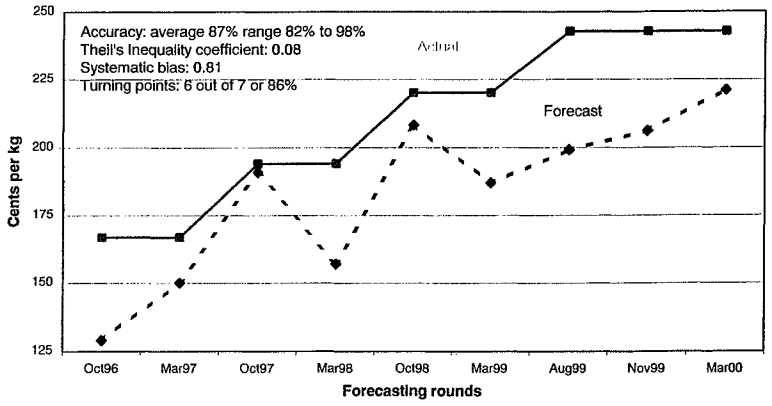
Milksolids average payout forecast vs actual for May years t+1



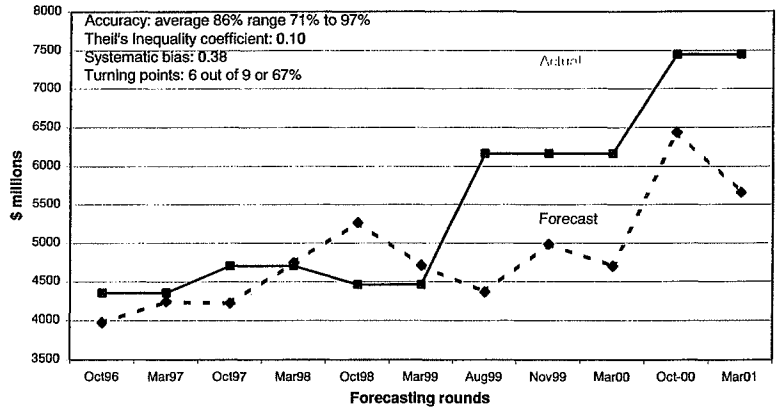
All grades average lamb price forecast vs actual for June year t+1



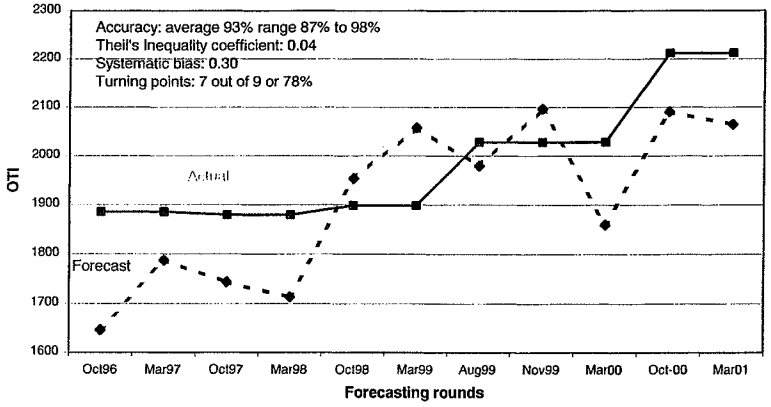
Manufacturing cow 145.5 - 170 kg forecast vs actual for June year t+1



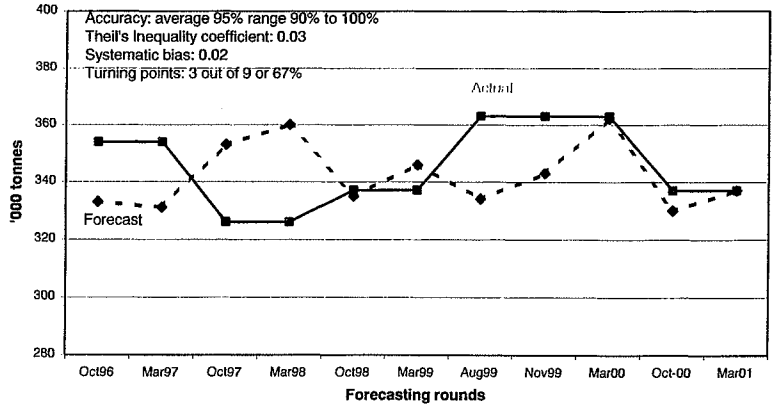
Dairy export values forecast vs actual for March year t+1



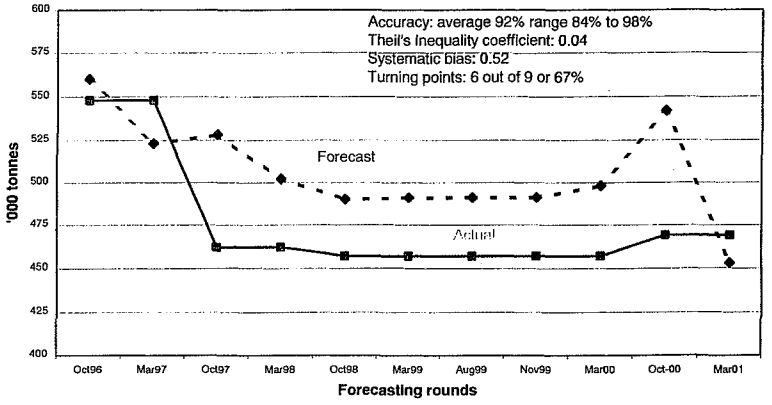
Dairy volume overseas trade index forecast vs actual for March year t+1



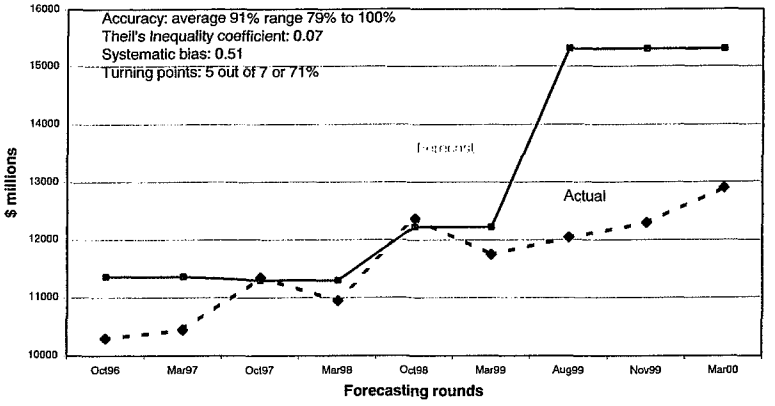
Lamb export volumes forecast vs actual for March year t+1



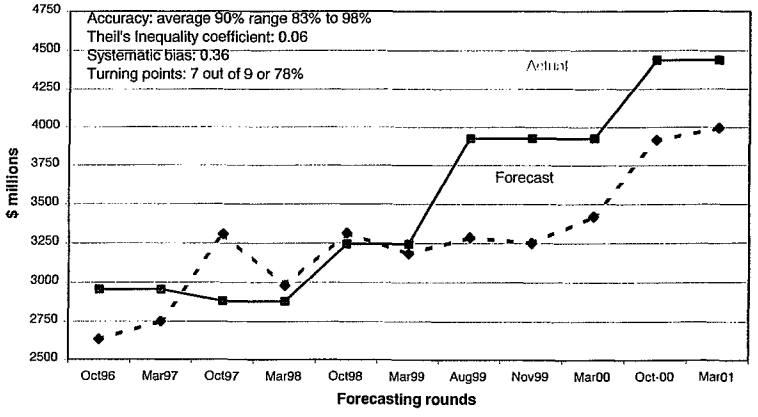
Beef export volumes forecast vs actual for March year t+1



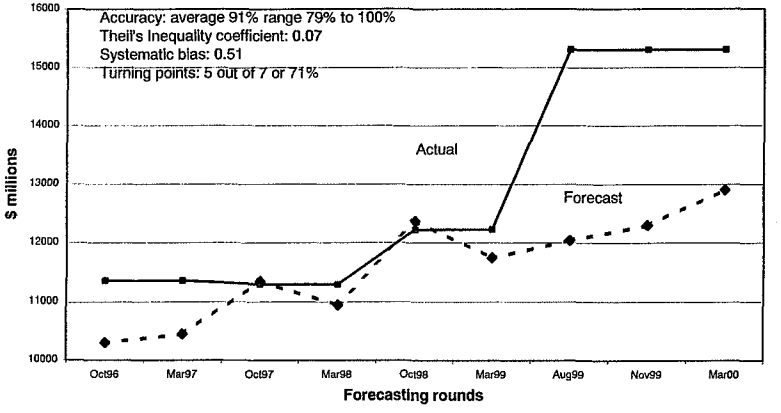
Gross agricultural revenue forecast vs actual for March year t+1



Meat export values forecast versus actual for March year t+1



Gross agricultural revenue forecast vs actual for March year t+1



NOT JUST COUNTING SHEEP

REINSTATING ANNUAL SURVEYS FOR NEW ZEALAND'S AGRICULTURAL SECTOR

Paper presented at the 16th Australian Statistical Conference
Canberra (7-12 July 2002)

and

the New Zealand Agricultural and Resource Economics Society.
Blenheim (5-6 July 2002)

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NOT JUST COUNTING SHEEP

REINSTATING ANNUAL SURVEYS FOR NEW ZEALAND'S AGRICULTURAL SECTOR

INTRODUCTION

When in 1997 New Zealand ceased 'counting sheep' through the official Agricultural Production Survey, the task of forecasting the contribution of agriculture and horticulture to the New Zealand economy became more problematic. As an example, the impacts of two years of drought in 1997 and 1998 were not quantified adequately and gross agricultural product was overestimated for these years. The implications of this for monetary policy caused concern throughout the economy and were a factor in the decision to reinstate the survey. The government approved two years of new initiative funding in 1999 (Vote: Agriculture and Forestry) to collect agricultural statistics.

In 2001, the Ministry of Agriculture and Forestry (MAF) was successful in obtaining ongoing funding to reinstate the collection of official agricultural statistics. A census, collecting statistics on livestock, horticulture and forestry, will be undertaken every five years, commencing in 2002. Sample surveys will be conducted in intervening years. The 2002 census is being conducted jointly with Statistics New Zealand (SNZ). MAF and SNZ have agreed to work together on the Agricultural Production Statistics programme. SNZ is responsible for undertaking these large-scale surveys and producing the 'Official Statistics'.

Resuming the collection of these statistics is of interest because of the technical and statistical issues that must be addressed in undertaking a collection of this nature. The challenge for a successful reinstatement of the Agricultural Production Survey (APS) is to work towards a collection that conforms to high standards of coverage, frequency, accuracy, timeliness and consistency.[1]

The joint contribution of agriculture, forestry and horticulture to gross domestic product is estimated at just over 7 per cent. Combined with the processing and manufacturing industries, the sectors contribute around 17 per cent to New Zealand's gross domestic product. Their contribution to New Zealand's exports for the year ended March 2002 totalled $20.6 billion fob (or 66% of total exports).

DATA COVERAGE

Core statistics such as the number of farms, area farmed and livestock numbers had been collected annually in New Zealand as far back as 1861. The two years of funding obtained in 1999 was used to collect livestock numbers and areas sown in grain and arable crops in 1999, and statistics on areas planted in fruit and vegetables in 2000. These surveys also collected information on farm type, land use, business type and locality.

Prior to 1990, information on production levels was regularly collected in the APS. In those years the survey also included questions on, for example, the gross cost of assets, disposal of assets and the numbers of people working on farms.

[1] See references on p10.

In 2002, in addition to livestock numbers, production data for grain, seed and arable crops, deer velvet and arable crops harvested for silage or balage will be collected. The net area planted will be collected for fruit and vines. However, to estimate production for horticultural crops reliable industry information on prices and yields must be gathered. For vegetables, the area harvested in hectares will be captured in 2002. Prior to 2000, the APS collected the area grown for the various vegetable crops. This change was introduced in 2000 to allow double cropping activities to be captured, enabling MAF to produce better estimates of vegetable production.

Livestock numbers will be collected in more detail in 2002 than in the 1999 survey. For example, a greater number of sex/age variables are included, and there are questions on lambing and calving. More variables will be collected for horticulture compared to those collected in 2000.

The following topics will also be included in the 2002 census: new forestry plantings, timber harvesting, area irrigated and able to be irrigated, quantities of fertiliser applied by type, activities carried out on land leased from Maori trusts, numbers of animals grazed but not owned (e.g for rent) and the land areas classified as 'organic' (these topics were not included in the 1999 and 2000 surveys.)

A separate survey of small forestry growers will be conducted in 2003 to collect detailed information on forests of less than 40 hectares in size. This information will be used in MAF's National Exotic Forest Description and will assist with forecasting the future wood supply from these small blocks.

More work remains to be done to improve the collection of certain data such as land use information and the areas used to grow vegetable crops. For example, we are not currently collecting the total productive area used for vegetable growing.

Issues involving the snap shot information collected as at 30 June and information which applies to an entire year also requires investigation because land use data for horticulture does not match that collected for the various crops as closely as could be expected.

The APS is not considered suitable for collecting information on employment, and financial statistics through the APS ceased over a decade ago. A logical next step would therefore be to extend the collection of Statistics New Zealand's financial statistics and also to cover employment through, for example, the Quarterly Employment Survey.

Statistics on stock numbers, land use and areas planted will be collected as at 30 June 2002, while harvests, calving and lambing statistics will refer to the year ended 30 June 2002.

The information collected in 2002 will be published at the territorial authority level, regional council and national level (subject to confidentiality and quality standards).

When the data becomes available in May 2003, it will be the first time in six years that district planners will have access to up-to-date core statistics. For example, the number of dairy farms, the hectares of land occupied by the various farm types, numbers of livestock and land use statistics will become available for their district.

FREQUENCY

The baseline funding received by the Ministry of Agriculture and Forestry will enable it to fund large annual agricultural surveys. However, not all of the desired information can be collected each year. Factors such as the compliance costs placed on respondents, the needs of users, and the costs of collection must all be considered.

The 2002 census is the first of what is expected to be a regular cycle of censuses and surveys as part of the Agriculture Production Statistics Programme.

The collection frequency of the variables will be set out in a plan for the next 10 years (to be completed shortly). Alternating the focus in the questionnaire each year from livestock sex/age splits to horticultural crop splits will enable the main needs of users to be met. The programme for 2002 and beyond is likely to be as follows:

VARIABLE CATEGORIES	2002	2003	2004	2005	2006	2007
Livestock totals by type	✓	✓	✓	✓	✓	✓
Livestock totals – breeding stock	✓	✓	✓	✓	✓	✓
Horticulture totals by type	✓	✓	✓	✓	✓	✓
Farm/grower information	✓	✓	✓	✓	✓	✓
Land use/farm counts/business type	✓	✓	✓	✓	✓	✓
Livestock sex/age splits	✓	✓			✓	✓
Horticulture – crop splits	✓		✓		✓	✓
Forestry planting/timber harvesting	✓		✓		✓	✓
Forestry wood supply < 40ha		✓				
Leased Maori land	✓					✓
Fertilisers	✓	✓		✓		✓
Grain and arable crops	✓	✓		✓		✓
Grazing of livestock for rent	✓	✓		✓		✓
Irrigation	✓		✓			✓
Organic farming	✓		✓			✓
Sheep breeds/wool production, etc.		✓		✓		
Horticulture production levels			✓		✓	

ACCURACY

Sampling errors (these do not apply for the 2002 census)

It is possible to apply standard techniques of error measurement to the agricultural statistics collection. Survey samples can be designed to meet pre-determined quality standards (e.g. the variability of the estimate due to sampling at the national level for total beef cattle will not exceed 1 per cent based on a 95 per cent confidence interval). The expected standards required for some of the variables collected in the APS survey are given in Table 1 below:

Table 1 : Quality Management Information – Agricultural, Forestry and Horticultural Statistics

	Sampling Errors	
	National level	Regional Council
Hectares in grazing land	1%	3-5%
Total sheep	1%	3-5%
Beef cows & heifers (breeding) 2 yrs & over	1%	3-5%
Beef breeding bulls	1-2%	3-5%
Dairy cows & heifers (over 1 year) in milk or in calf	1%	3-5%
Apples	3-5%	5-10%
Onions	3-5%	5-10%
Total planted production forest	1%	3-5%

Non-sampling errors (these will apply in the census and in any other sample survey)

Errors arising from biases in the patterns of response and non-response (via imputation) cannot be quantified. For example, some respondents may enter data for processed peas (a vegetable grown outdoors) in the grain, seed and arable crops section under 'field peas'. The difficulty of quantifying errors also applies to inaccuracies in reporting by respondents and errors in the recording and coding of data. Testing of the questions for each survey helps to reduce this type of error. The quality of the estimates produced from the 2002 Agricultural Production Census remains heavily dependent on the ability and willingness of farmers and growers to complete the survey form as accurately as possible. One of the key messages of the publicity strategy for the 2002 Agricultural Production Census is to make farmers aware of the need to complete the census form accurately.

Imputation (or statistically accounting for non-response)

In 1999 non-response was estimated by using a mean imputation method. This approach left approximately 15 per cent of data unclassified for variables such as farm type and herd size. To overcome this problem in 2000, non-response was estimated using a method called 'hot deck' imputation. Hot decking involved grouping responding and non-responding units, in the same region, together in 'imputation cells'. Non-respondents were then randomly assigned to another respondent within the imputation cell. The characteristics of each selected respondent were then applied to the non-responding unit. (Note: Respondents with uncharacteristically high levels of horticultural activity were removed from the imputation cells.) A similar process of imputation is envisaged for the 2002 census.

Trade-off between accuracy and timeliness

As agricultural statistics will be collected annually, the trade-off between accuracy and timeliness is not as pressing a factor as for quarterly data collections. The reinstatement of the APS has, of course, required the re-establishment of processing systems and the population frame - the list of farms from which samples can be drawn.

The development of the frame for the 2002 census is covered in more detail later in this paper. However, the importance of an accurate, up-to-date frame can be seen from recent history. The Survey coverage in 1999, taken from AgriBase, the land-based frame maintained by AgriQuality New Zealand, was found to be inadequate in some regions. Consequently, the release of the survey provisional data was delayed to the end of February 2000 in order to enable extra work to be carried out on the estimates. When horticultural enterprises were surveyed in 2000, the list of growers was compiled from a number of different sources to avoid under-coverage. A census of all units on the list was held and this time much extra work had to be carried out because of duplications and the inclusion of enterprises that were no longer engaged in horticultural activity. Again, the provisional data was not released until February 2001.

One of the most important uses of the APS is to provide accurate base data for agricultural forecasting. It is highly desirable to have accurate final data from the APS at the end of February for use in MAF's forecasts that are prepared for New Zealand's Budget Economic and Fiscal Update.

With debate on the value of agricultural production taking place without up-to-date information, users of agricultural statistics are looking for a collection that will provide them with reliable trends in livestock numbers and related statistics.

Probability samples introduced

Probability samples for the APS were introduced in 1995. This change provided users with quality measures for the statistics produced. However, the size of the errors for some of the estimates was surprisingly large. For example, in 1996 when the sample errors and combined errors (sample error^2 + imputation^2 + instability^2)$^{0.5}$ were taken into consideration the following results were achieved for the national estimates:

- Dairy cattle and sheep had the desired sample error of 1 per cent or less and a good combined rating (0 per cent combined error α 15 per cent).

- The other livestock totals achieved fair combined ratings (15 per cent combined error α 25 per cent).
- The sample error published in 1996 for total deer and total pigs exceeded the desired 1 per cent level at 2.2 per cent and 7.6 per cent, respectively.

At the farm type and regional level, errors included poor (25 per cent combined error α 40 per cent) and very poor ratings (40 per cent combined error) for some estimates. Some of the horticultural estimates were suppressed because of poor quality.

Population frame - a complete list of farms

The quality of the APS estimates is directly linked to the completeness of the frame - the list of farms. The main difficulty facing the reinstatement of the collection is the development and maintenance of the frame and this is a key objective of the 2002 census. Following its initial development, the next steps involve the continual updating of the frame using the information from each collection. SNZ and MAF have agreed to devote both staffing and financial resources to maintain the frame.

The 1998 Review of Agricultural Statistics provides a useful historical insight into the structure of the sectors and the implications of this for the APS frame and the estimates produced. One of the reasons for switching in 1994 to the GST-based business register (businesses whose turnover exceeded $30,000 were legally required to register) was the degradation of the existing land-based frame. Maintaining the frame had involved the laborious task of updating ownership details for each land parcel within the scope of the APS.

Subsequently, the 1998 Review found (based on the results from the 1994 APS census) that enterprises "within the agricultural population with annual GST turnover/expenditure of less than $30,000 p.a. do make a significant contribution to the key output values (see Table 2 below).[2]

Table 2: Contribution to the National Estimates from Farms with < $30,000 p.a. Turnover/Sales[2]

Farm Type (ANZSIC)	Percentage Contribution (per cent)										
	Land	EVAO*	Barley	Wheat	Apples	Kiwi-fruit	Sheep	Beef	Dairy	Deer	Poultry
Horticulture	0.2	2.1	0.2	0.4	7.8	24.2	0.1	0.2	0.1	0.1	-
Grain/sheep/beef	3.3	1.6	4.7	6.1	0.1	-	4.0	5.4	0.1	0.8	-
Dairy	0.5	1.1	0.2	0.3	-	0.1	0.1	0.3	3.9	0.4	-
Poultry	-	-	-	-	-	-	-	-	-	-	3.5
Other livestock	0.4	0.5	0.6	-	0.1	0.2	0.3	0.4	0.3	9.8	-
Crop	0.4	0.1	0.3	0.3	-	-	-	-	-	-	-
Forestry	-	0.8	0.1	-	-	-	0.1	0.2	-	0.1	-
All farm types listed	4.8	6.2	6.1	7.1	7.9	24.5	4.6	6.5	4.4	11.2	3.5

*Estimated value of agricultural output.

[2] See references on p10.

Farms whose GST turnover was under $15,000 p.a. also made a significant contribution to some of the 1994 estimates. For example, these farms contributed 3.7 per cent to the national beef cattle estimate, 5.4 per cent to the national deer population, 6.0 per cent to total wheat, 13.4 per cent to the total area planted in kiwifruit and 4.8 per cent to the area planted in apples.

The 1998 Review also questioned the effect on the survey estimates of removing those enterprises not registered for GST (some 12,000 units were removed). It concluded that without an enumeration of the contribution of the missing enterprises, it was not possible to reliably determine their effect on the APS estimates.

The 1998 Review included a discussion on list frames such as the SNZ business register and area frames such as AgriBase.[3] The review discusses several advantages of having an area-based frame:

- "The strength of an area frame lies in the fact that the frame does not easily become incomplete or out-of-date.
- Changes in farm ownership are not as problematic in an area frame, when compared to a list frame. This is because the sampling or statistical unit is a piece of land thus the frame can be used to survey any item that can be associated with land.
  A disadvantage with an area frame can be the higher initial establishment costs compared with a list frame."[4]
- Another advantage of a land-based frame is that it lends itself to analysis in a geographic information system.

The medium term goal for the agricultural statistics collection is to develop a land-based frame.

The findings from the 1994 census relating to small businesses suggests that some small businesses are likely to be missing from the frame used for the 2002 census and the effect of this under-coverage on the estimates will remain unknown.[5] An example of the type of enterprise that may not be on the list is the grower or farmer whose primary income is not sourced from agriculture and who is not registered for GST. This type of unit is unable to be identified in the tax register as being involved in agriculture.

The fact that the GST registration threshold now stands at $40,000 p.a. turnover is another factor to consider. With low levels of inflation in recent years, and an increase in the threshold, farms not registered for GST may also have increased in number. There is also the increase in recent years in the number of lifestyle blocks to consider. The question must be asked for the 2002 population whether the contribution to the livestock estimates by farms less than 5 hectares in size (these are included in the 2002 population) is still insignificant as was the case in the 1994 census?

In an attempt to include all units on the frame, the 2002 census questionnaires will be sent to all enterprises which have been identified as being engaged in agricultural activity irrespective of the size of the land holding or turnover.

[3] AgriBase is maintained by AgriQuality New Zealand Ltd (a state owned enterprise) and its main purpose is to provide a tool for responding to and managing any problems that may limit New Zealand's agricultural productivity or ability to trade.

[4] See references on p10.

[5] See references on p10.

The population for the 2002 Census is defined as all enterprises on the Inland Revenue client register or on the Statistics New Zealand business register which have not filed a zero tax return (GST, IR3 and IR10) between 1 July 2001 and 30 June 2002. This definition was used as a means of identifying those assumed to be engaged in agricultural production during the reference period.

The 2002 population definition provides a much more comprehensive list of farms than that used for the 1994 census. The inclusion of IR3's ensures that the self-employed engaged in agriculture will be included. Using a tax-based list frame allowed the census to be conducted in 2002 thus ensuring that statistics will come available in February 2003, after a two-year gap for livestock numbers. It was not possible in the time frame available to fully supplement the frame with all contact information from AgriBase and other volunteered producer lists without risking large numbers of duplication. Another consideration was the out-datedness of some of the information from AgriBase.

While all efforts have been made in 2002 to avoid double counting, duplication and under-coverage of farms are likely to be significant sources of non-sampling error in the 2002 collection.

Maintaining and refining the population frame

Farm details will be collected each year (including questions relating to disposals of land, share-milking activities and leasing of land) for maintenance of the registry of farms from which surveys will be run. This refining of the newly-formed list frame for future surveys will assist in the production of high quality statistics.

Systems for birthing new farms and removing farms that have gone out of existence have been set up. The complexity of today's farm ownership structures, the rate of change in farm ownership, and the costs involved in surveying large numbers of farmers and growers, all impact on the cost of frame maintenance and on the size of the frame.

Steps must also be taken to extend the coverage of the frame to include enterprises that farm for profit and which are unable to be identified in the tax system. These small businesses may contribute significantly to some of the APS estimates.

Over the foreseeable future, we will continue to use SNZ's business register as the foundation of the population frame and to integrate the agriculture component of this register with AgriBase. To integrate these frames, farm details from the census will be passed to AgriBase (where respondents have given their consent). For this reason, the 2002 questionnaire includes a question that seeks respondents' consent for SNZ to supply information to update AgriBase.

More work on quality needed for horticultural estimates

The sample surveys conducted in 1995 and 1996 showed (see table 3 below) that the quality of the estimates for some horticultural crops fell well below acceptable levels. It will be necessary to ensure that sampling errors for future surveys are kept within the bounds indicated in Table 1. This may mean holding large sample surveys and censuses (approx. 15,000 enterprises in total) for the larger horticultural collections.

Table 3 : Sample Errors for New Zealand's Main Horticultural Crop Estimates

	Kiwifruit	Apples	Wine Grapes	Avocados	Strawberries	Pears
	%	%	%	%	%	%
1995	2.5	2.0	7.9	26.7	53.5	9.3
1996	3.5	2.5	7.1	Not published		11.1
	Onions	Peas	Squash	Sweet Corn	Carrots	Capsicum
1995	28.9	8.1	15.4	11.3	14.1	79.4
1996	25.5	7.8	Not Published			

Changing user requirements and the APS

Currently, the definition of the farm used for the APS is "an enterprise engaged in agricultural activity with the intention of selling production or which owns land intended for agricultural activity."[6] To fully satisfy New Zealand's reporting requirements for climate change purposes this definition may need to be extended, or the relevant information may need to be collected separately from the APS. Climate change reporting involves estimating methane emissions from livestock, release of nitrous oxide from soils and the different forms of nitrogen released as a result of fertiliser application. Information is required on total livestock numbers not just those on farms run for profit. This raises the question as to whether the number of animals kept on lifestyle blocks is significant for climate change reporting.

TIMELINESS

The 2002 census involves a post out of over 90,000 questionnaires. While the processing of the questionnaires will take longer than for the previous two surveys, the census results are expected to be available in February 2003. In comparison, the 1999 survey involved a sample of 35,000 livestock farmers and the final farm count for the horticultural census was just over 14,000.

The provisional estimates for the 2002 Agricultural Production Census are expected to be released on 21 February 2003. On this date only national estimates will be released such as total sheep, calves born to dairy cows and heifers and area planted in apples.

The final 2002 estimates are expected to be released on 28 May 2003. Data will then become available at the territorial authority and regional council level.

For the inter-censal surveys, users consider the release of the provisional estimates 8 months after the reference year as unsatisfactory. The aim for future surveys will be to publish the information earlier and if possible to meet the expectations of users.

With scanning of the completed questionnaires possibly being trialled in the 2002 census it is possible that questionnaire processing will be quicker than was possible in the past. At this stage it is not clear as to how much processing time will be saved for the 2003 survey.

CONSISTENCY

The approach to the 2002 collection of livestock numbers has been to collect *all* of the various sex and age splits for each livestock type as was done in the past. Respondents will also

[6] Includes horticulture and forestry.

be asked to provide a total for each livestock type. Testing showed that the questions worked well. As not all information can be collected each year, a different questionnaire will need to be developed that ensures consistency in the livestock numbers collected from year to year.

Collecting consistent and robust horticultural crop statistics poses greater challenges than producing livestock statistics. The 1995 and 1996 survey results indicate that the sampling errors achieved at the national level were unacceptably high, even for some of the major vegetable crops. Some fruit and vegetable crops could not be compared across localities because the data collected in 2000 was only available at the regional council level while the previously published data for 1994 and 1996 was at the territorial authority level. The large size of the task of reclassifying previously collected data to the current regional council boundaries is likely to prevent this type of analysis becoming possible in the future.

In future, the storage of unit record data on computers and the increasing use of classification concordances will make it possible to set up time series that match any changes that take place to regional boundaries.

From 1999 onwards, the APS survey results have been classified using the Australia New Zealand Standard Industrial Classification (ANZSIC). The surveys have asked for 'main activity' and 'major sources of income' since the early 1990s. For farms where one activity is clearly predominant, the information collected in the questionnaire is adequate. Where activities are mixed, some misclassification is possible. The ANZSIC classification is based on a value added concept while farmers are more likely to record their gross income for each activity. Regular testing of the income and activity questions will ensure the accurate and consistent classification of farm types.

As information is being collected based on what is happening on the farm (irrespective of the predominant activity) it will be possible to publish information based on, for example, the number of sheep on all farms - not just those on 'sheep farms'.

The challenge for future surveys and censuses is to design a collection that balances the need to capture significant changes in New Zealand's agricultural sector and preserves continuity of the time series which are an essential input into calculating the contribution of the agricultural sector to the economy.

DOCUMENTATION

The agricultural statistics published by Statistics New Zealand come with technical documentation informing users on data quality, concepts, definitions and caveats. The APS statistics published on the MAF web site (www.maf.govt.nz/statistics) also include technical notes.

The survey results will be published by Statistics New Zealand on their web site (www.stats.govt.nz). The SNZ web site also holds information such as the answers to frequently asked questions, information on agriculture from Yearbooks, Key Statistics articles, etc. For information about the 2002 census use the link www.stats.govt.nz/agriculturecensus2002. A sample copy of the 2002 questionnaire can be found at www.maf.govt.nz/statistics/primaryindustries.

DISSEMINATION

The statistics from the Agricultural Production Survey are released to all users at the same time. Prior notification will be given to users as to when the statistics will be released and any changes to publication dates are widely advertised. The data from the APS will be made available to all users on the SNZ and MAF web sites.

Data will be published in standard tables, for example, dairy cattle numbers by age, sex and territorial authority. Tables providing summaries of, for example, all livestock types by regional council will also be produced. Other examples of data to be published include: counts of farms by farm type, land use by territorial authority, hectares in planted production forest and business type information.

Other information will be available on request (subject to confidentiality and quality constraints) to meet individual user needs.

Increasing accessibility to existing statistics already collected by Statistics New Zealand covering the agricultural sector could be part of a wider strategy to meet the needs of agricultural statistics users. For example, more regional time series data could be published such as area planted in apples in Hawke's Bay and Tasman. This will make the on-going agricultural statistics collection even more useful.

CONCLUSION

Reinstating the Agricultural Production Survey is a first step to return New Zealand to a well-developed system for the regular collection of farm statistics that started in 1861. Government has allocated $1.3 million to develop the 2002 census and a further $2 million to implement it. Holding regular censuses and surveys will ensure that a flow of statistical information will continue to shed valuable light on New Zealand's agriculture, forestry and horticulture.

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Mieke Wensvoort was seconded from Statistics New Zealand in December 1999 to assist the Ministry of Agriculture and Forestry with the interpretation and dissemination of the results of the 1999 Agricultural Production Survey. In 2000, Mieke developed a structure to disseminate agricultural statistics on the MAF web site and she is responsible for the management of MAF's statistics site. Mieke commenced permanent employment with MAF in August 2001 to assist with the ongoing collection of statistics on agriculture and horticulture. Following the publishing of the horticultural statistics in 2001, Mieke coordinated MAF's input into SNZ's questionnaire design process for the 2002 Agricultural Production Census. She also led the 2002 Census Publicity Strategy and she has worked on the development of a long-term strategy for the ongoing collection of agricultural statistics.

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A Framework For Policy Agencies To Design And Evaluate Communication Strategies To Achieve Behavioural Change

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Summary

For peoples' behaviour to change, their attitudes must change as well. Persuasive communication by policy agencies has a role to play in encouraging attitude change among their constituents. There are four stages to attitude change, and these are affected by whether people engage in high elaboration or low elaboration processing of communication messages. To encourage the changes in attitude that are associated with desired behaviour a communication strategy should address the underlying processes for both types of elaboration. A strategy for doing this is likely to include: segmentation, attitude change identification, message design, design for heuristics or conditioning, learning skills, communication channels, and supporting conditions. Actual communication activities can then be planned to apply the strategy in ways that combine both high and low elaboration approaches.

Key words: communication, strategy, attitude, elaboration likelihood

Background

A communication strategy is an important mechanism for policy agencies to achieve attitudinal change on environmental issues. Having a strategy ensures that the Council's communication efforts are focussed and goal orientated, that resources are used efficiently, and it provides benchmarks for Council staff to use in evaluation and learning. It is sometimes assumed that if good communication is essential for the public to co-ordinate their activities with policy agencies so that everybody works together for a common outcome, poor communication itself can't do any harm. At the worst, it might be assumed that poor communication could cause some confusion and slow down the rate of progress. However, the evidence from overseas and New Zealand is that poor communication results in greater polarisation on issues amongst catchment communities and Policy agency staff. This in-turn leads to entrenched attitudinal differences, a lack of trust in local officials, and human resources being diverted to 'spoiling activities', and dysfunctional behaviour (e.g. Williams 2001, Holderness-Roddam 1997, Ostrom 1999). In such situations, unless the issues underlying attitude polarisation are addressed, Councils can expect to achieve at best, compliant behaviour in communities based upon submissive relationships and cost minimisation.

A communications strategy for persuasion is quite purposeful in its intent with a goal benefiting the source (O'Keefe 1990). It should also be voluntary, so that recipients can choose whether or not to participate in the act of communication. It differs from consultation or learning interventions (Table 1) that are more process orientated, in that it is intended to persuade people towards a specific attitudinal position. Other communication approaches, when the recipients have limited or no choice about participating in the communication act, may be considered to be propaganda or coercive (Table 1).

Table 1. Types of Communication and Their Differences

	Goal Focussed	Process Focussed
Voluntary	persuasion	consultation, learning
Restricted choice	propaganda	coercion

Attitude Change And Communication

Persuasive communication ordinarily aims to change attitudes that are linked to specific behaviours (e.g. planting a 5 metre riparian strip in flaxes and native trees). Attitudes are evaluative predispositions to view specific behaviours as being positive (good for me) or negative (bad for me) (Eagly and Chaiken 1993). They are not innate (or genetically inherited) but are learnt through experience. Attitudes tend to be relatively enduring compared to other psychological states that may be more emotionally based such as people's moods.

Receiving and processing information associated with attitude change involves people in the following stages (Petty and Cacioppo 1986):

a. Attention – people being motivated to think about an issue.

b. Comprehension – people being able to process information clearly and relate it to their own belief structure.

c. Yielding – people being able to identify the arguments being presented and evaluate these to produce a change in attitudes.

d. Retention – people integrating their new attitude with their own sense of self, so that it becomes part of their revised belief structure.

At each of these stages, people use a range of learning skills for processing information to build new knowledge and add it to their existing experiences (Kolb 1986). Learning processes involve separate steps of appreciation and transformation. People can appreciate new information through comprehension of the central concepts, or through the felt qualities of an experience. Following appreciation, information is transformed and made more relevant by either a process of internal reflection or by actually trying it out.

Each combination of appreciation and transformation processes is associated with a different type of knowledge. So there are four types of knowledge, from divergent to assimilation to convergent and then to accommodative, each with their own set of learning skills (Table 4).

Table 4. A Description of the Common Types of Knowledge and Learning Skills

Appreciation of information	Transformation of information	Types of Knowledge	Learning Skills
comprehension	reflection	assimilation: knowledge that is strongly theoretical	thinking, organising information, testing theories, analysing data
	try it out	convergent: problem solving	decision-making, setting objectives, experimenting with new ideas
felt qualities	reflection	divergent: imaginative and people centred	information gathering and imagining the implications of change
	try it out	accommodative: action and risk taking	applying feedback and evaluation, and influencing and persuading

In any situation, individuals will tend to be more confident with one form of knowledge than any of the others. They will also tend to use the learning skills associated with that type of knowledge more than the others. All types of knowledge are needed for substantial learning to take place (Kolb 1986), and as people learn they will become more committed to using their new ideas as their knowledge about an issue grows.

Communication strategies are persuasive when they build upon people's learning skills, and support their use through the different stages of attitude change. Communication strategies focus the resources of policy agencies to address these learning needs and attitude stages. Any gaps that appear in communication strategies are likely to become the factors most limiting to their effectiveness. Described in a strategy will be the different population segments to be addressed, the attitude changes desired for each of them, the communication channels to be used, the messages and heuristics to be developed and the supporting conditions to be set. From the strategy, specific communication events can be included in an operational plan.

Communication influences peoples' attitudes through more than one route. People have been found to change their attitudes when they are exposed to messages that associate certain concepts to emotional cues. Examples include a specific model of car and images of power, or cigarettes and unhealthy bodies. These are all related to conditioning processes of attitude change (Petty and Cacioppo 1986). In other, or similar situations people have responded to the central messages contained in a communication. Communication strategies can be developed to address both these types of thinking (conditioning and message based).

Communication Strategies

Communication messages, the robustness of their arguments and strength of delivery are not the only way to make communication effective. Poor arguments and weak delivery in the right situation can be equally effective. Early communication models struggled to address the issues associated with both cognitive communication (aimed at influencing peoples' reasoned decision making) and affective communication (aimed at influencing peoples' intuitive decision making). The Elaborative Likelihood Model (ELM) has been used to integrate these so that communication stages can be specified to influence both these types of decision-making (Petty and Cacioppo 1986). The model accounts for two communication routes to achieve persuasion – the central persuasion route and the peripheral persuasion route.

The central persuasion route operates when people think about the contents of the communication process and engage (internally or externally) in reasoned argument i.e. there is a high elaboration of ideas in the message. It requires a greater effort to carry out the processing involved in high elaboration, but people consider themselves to be more accountable for the results of their central processing and it is more likely to provide them with a learning experience.

The peripheral persuasion route operates when people have a low level of awareness about the communication message i.e. engage in low elaboration, and so peripheral cues (such as the attractiveness of the speaker) become more important for attitude change. Peripheral processing requires less energy, and concentration, it occurs easier and faster then central processing. Attitude changes from peripheral persuasion routes are less useful for predicting behaviour, more susceptible to counter persuasion, persist for a shorter period of time and people take less individual responsibility for the results.

Both the central and peripheral thinking can operate over the same time period. They are part of the same communication continuum and people will tend to be dominated by one or the other depending upon the significance to them of the issue, the source of the communication, the channel being used, and the type of message being conveyed (East , 1990).

People may consider that the significance of an issue is low when it appears to them to have no relevance (benefit or cost) to their lives. Significance can also be low in situations where people may have some involvement in the subject but they lack knowledge or understanding about what is happening or why. When the significance of the communication is low, people may pay less attention to the central arguments and so their pre-existing attitudes will dominate the effectiveness of any attempted communication by policy organisations (Table 2).

If people consider the issue to be very important to them because they are highly involved or very knowledgeable about the subject or even just very curious, they are more likely to use the central communication route. When that happens, the arguments within the communication are of direct importance for attitudinal change.

Table 2. Effect of the Significance of the Issue and Pre-existing Attitudes Upon Message Processing

Significance of Issue	Contrast of Message with Existing Attitudes	
	Pro-attitudinal	Counter-attitudinal
Low	mostly peripheral processing.	mostly peripheral processing.
High	large attitude changes are possible using central processing.	small attitude changes are possible using central processing, possible risk of rejection.

Some communication guides are written for preparing one-off communication events. But a strategy is not just a series of one-off events strung together in the hope that they will eventually have an effect like "water dripping on stone". Strategic decisions set the overall direction and framework for communication activities and one-off events by policy agency staff. For strategic planning, policy agencies will need clear communication goals linked to performance objectives with ways to monitor the results of their communication operations and take corrective action as required (CCH 1992). Any formalised strategic planning process must be flexible enough to encourage imagination, learning, and creativity, all of which are required if the plan is to be successfully applied in a rapidly changing environment (Martin, Pittaway and McCrea, 1990).

Table 3 can be used as a checklist for designing a communication strategy aimed at achieving behavioural change. It makes a distinction between high elaboration activities encouraging message processing and low elaboration activities with an emphasis upon processing peripheral information. The only component that differs between these processing approaches is the 'message' component for people engaged in high elaboration thinking and the 'heuristics or emotional associations' component for people engaged in peripheral elaboration thinking. However each of the other components differs in application between these two processing approaches and these differences are explained further in the following sections.

Segmentation Into Decision Making Systems

Deciding whether to segment the public for communication purposes, and into how many segments to form them are the initial steps in the strategy. Without segmentation the strategy will mainly reflect the policy agency's need for communication. With segmentation, a policy agency's effort becomes a lot more targeted and their public has greater influence in having their needs met as well (East 1990).

Table 3. Processing Route and Components for a Communication Strategy

	Processing Route	
Components	High Elaboration using Central Processing	Low Elaboration using Peripheral Processing
1	segmentation into decision making systems	segmentation into decision making systems
2	attitude change	attitude change
3	messages	heuristics or emotional associations
4	communication channels	communication channels
5	supporting conditions	supporting conditions

Segmentation for communication by policy agencies divides the audience into homogenous groups around key decision-making domains. These recognise that for different people a specific behaviour may be influenced by a set of outcome related decisions. To segment a community, the characteristics associated with their decision domains must be measurable and the data accessible (although it may require research). The segment itself must be accessible so that they can be party to the communication. The segments should also be large enough so that the policy agency's resources do not become too fragmented. In some instances associated with land management there will be a need to split the audience into at least the landowners and their service industries (contractors, merchandisers, advisers, etc). Other bases for segmentation include attitude, demographic factors (e.g. age and gender) and sociological factors (e.g. family and business size).

When considering dairy farmer effluent management in the state of Victoria, 91% of their 8000 dairy farmers could be segmented into six groups (Parminter, *et al* 2001). One of these segments related to 40% of the farmers. In that segment the key belief for a positive attitude toward effluent management was for farmers to associate effluent management with milk harvesting as good business practices. Communication unrelated to the beliefs of this segment would be unlikely to affect their attitudes and the behavioural outcomes desired by the policy agencies actively engaged in dealing with this issue and so miss a large portion of the target audience.

Attitude Change

Although attitudes are linked to behaviours, the link varies in strength depending upon the specificity of the behaviour and other psychological and contextual conditions (Ajzen and Fishbein 1980). The more specific the behaviours which are the focus of a communication, the more specific the attitudes which need to be targeted by that communication (Parminter and Perkins 1997).

In a recent study of farmers riparian management (data unpublished) the most important psychological factor affecting their intentions to plant native or exotic trees were their attitudes towards doing so. For these behaviours, attitudes were more

important than peoples' perceptions about social norms or their confidence in being able to do the job as planned. Measurements of factors associated with changing attitudes could be used to predict changes in peoples' intentions to plant (R2=0.66).

Communication Channels

Communication channels vary in the level of involvement that they require from participants. Communication using mass media are the most unidirectional, conferences, seminars, or field days provide some opportunity for feedback to speakers, community groups generally provide a forum for on-going discussion, and one-on-one conversations have the most potential for interaction.

Mass media reaches people at the lowest individual cost. Arguments need to be kept simple if central processing is to be encouraged otherwise they best suit peripheral thinking. If the issue is complex it is better handled in a written form rather than as a video programme (O'Keefe 1990). Written material is self-paced, and people are able to access it when and where they require. This enables them to scrutinise it in greater depth. Internet material is used when it is easy to access, short, specific to people's needs, and easy to download for later reading at leisure (N Botha et al 2001). Video programmes are able to explain well issues that are highly context specific because they can show the environmental conditions and highlight the interactions involved.

Conferences, seminars, or field days encourage central processing of information when they are focussed and present well-structured arguments. If the arguments are weak then just increasing the number of arguments (or speakers) doesn't increase their effectiveness, rather people become more resistant to their appeal (Petty and Cacioppo 1986). Arguments that are poorly thought out (with apparent ambiguities, inconclusiveness, contradictions, etc) cause people to fallback upon their pre-existing attitudes to sort out any perceived conceptual difficulties. Demonstrations of results help people develop trust in the speakers and become more confident in any information that they may be unfamiliar with. Demonstrations also provide examples for people to work out and apply decision-making heuristics in their own situation. Attitude changes resulting from direct experience (whether the experience reinforces or contradicts a person's existing knowledge) are more enduring than attitude changes formed from inference when people reason a conclusion. This encourages people who engage in both central and peripheral thinking about the issues.

Community groups that address specific issues (e.g. monitor farms or learning circles) can be an effective means for communication (Petty and Cacioppo 1986). People are likely to remember the issues discussed and have longer lasting attitudinal changes when they are in a group rather than when they are in an audience with a speaker. Groups tend to encourage central processing of issues when there is enough background information to understand the subject matter, and reasoned discussion is being facilitated. In groups people tend to be more influenced by the arguments that they form and express themselves than in the points raised by others. They can therefore "talk themselves" into an attitude change during a discussion.

Groups can encourage biased information processing though, because people in groups tend to screen and select arguments that support the existing positions of dominant people in their groups. If people in groups are exposed to information that they are unfamiliar with, their attitudes and decisions tend to be more extreme than when people are acting on their own (Eagly and Chaiken 1993) – therefore there can be group-induced polarisation about many issues.

Groups can influence the attitudes of their members through both normative (i.e. social) influences and informational evidence. Normative influences operate when people conform to group standards that are related to social rewards and penalties. Informational evidence influences people, through their desire to align their attitudes and beliefs with a reality that has been (or is being) validated by the group. Due to normative and evidential influences, people in groups are more prepared to agree with factually wrong information than if they received the same information individually outside the influence of the group (Eagly and Chaiken 1993).

Supporting Conditions

The context in which communications take place also influences the attitudes of those involved. If people who are centrally processing information become aware of peripheral conditions (e.g. background noise, speakers mannerisms, etc) they may become distracted and so the communication is less effective. For people with low message elaboration, peripheral conditions are an essential component to their thinking.

If a message comes from someone (an expert) who is perceived to be authorative and trustworthy and that person presents arguments with sound reasoning and good evidence they will encourage people who are thinking about the issue to take account of their reasoning. Trustworthy people can still influence people with low elaboration thinking even if the perceived expert is poorly informed about the issue, or they present weak arguments.

Information sources that are considered to be biased or untrustworthy, but that are still generally regarded as knowledgeable about a subject can still be effective at engaging people no matter what the type of communication processing going on. In these situations people think about the issue and try and resolve themselves the tension between the information being supplied and any biases that it may contain.

Heuristics, And Conditioning

When people are only peripherally engaged in communication, then the arguments in a message become less important than conditioning or heuristics (Gilbert, Fiske, and Lindzey 1998). Conditioning occurs if people associate issues or objects with positive or negative stimuli through any emotional links with those same stimuli. Heuristics may be used for simplifying communication (O'Keefe 1990) reducing the need for the audience to think deeply about the arguments in a message. In these circumstances people may use such heuristics as "Credible sources can be trusted", or "I like the presenter so I'll agree with them", or "If all these other people agree with it then it is probably true".

Messages

In communication where people are actively thinking about an issue (centrally processing), attitudes can change as a result of a communication directed at their beliefs. People seek positive benefits from behaviour that is consistent with their attitudes. They perceive there to be a high likelihood that they will receive such benefits if the behaviour takes place. People generally believe there are also negative consequences from the same behaviours and that these consequences will have some perceived likelihood of occurring. For favourable attitudes the perceived benefits and their likelihood are greater than the perceived negative consequences and their likelihood (Fishbein and Ajzen 1975). For negative attitudes the reverse applies.

A strategy can address a range of beliefs about the consequences of behaviours related to attitudes. If some of the people develop a positive attitude about an issue this may be the result of:

Adding new supportive beliefs.

Increasing the favourableness of the existing supportive beliefs.

Increasing the belief strength (likelihood) of existing supportive beliefs.

Denying the existence of current countering consequences.

Decreasing the value of existing countering beliefs.

Decreasing the belief strength of existing countering beliefs

Changing the relative salience of existing beliefs

Conclusion

Attitude change encompasses a number of stages that can occur over short (part of one event) or long periods of time (a series of events). People employ a range of learning skills to process information at each stage, building up their knowledge about an issue and developing their commitment to making behavioural changes.

Policy agency strategies for persuading attitude change (and so behavioural change) can be enhanced by addressing both central and peripheral communication routes. It is not always necessary to have different communication events for each of these as with a bit of planning they can often be combined. However it is important that there are aspects of any event that reinforce the thinking of people engaged in either form of information processing.

Communication strategies will have activities that combine a range of communication channels, messages, heuristics, and supporting conditions. It is likely that to achieve this, policy agencies will have to combine their resources with other organisations and institutions already working to communicate with their target communities.

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Estimating the Price of Water in Pondicherry, India: A Framework for Policy Analysis

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ABSTRACT

A rapid increase in the use of tubewells for irrigation has led to falling water tables, increasing levels of salinity and falling crop yields. The Tank Rehabilitation Project, Pondicherry (TRPP) aims to halt this process through a participatory rural development programme to rehabilitate all irrigation tanks in the region over a seven-year period. Recognising the vital importance of the policy framework, this paper outlines the results of a water pricing study and makes recommendations to achieve optimal use of surface and ground water. The present financial cost of water faced by tubewell owners is well below the economic cost because tubewell owners pay only a nominal flat rate fee for electricity and receive subsidised drilling and loan finance. Tubewell owners face a marginal cost of water that is close to zero but because of their market power are able to extract significant rent from water buyers. The present policy framework is inefficient (it encourages wasteful use of water and electricity), inequitable (it subsidises tubewell owners but not water buyers) and unsustainable (it causes saline intrusion and a falling water table). The challenge is to find policies that will ensure that groundwater extraction is kept at sustainable levels and to find ways to efficiently allocate water between different users. The emphasis must be on identification of policies that are realistic within the current political and institutional framework.

Key Words: water pricing, government policy, India, irrigation, groundwater.

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1. INTRODUCTION

Pondicherry region is one of four enclaves which constitute the Union Territory of Pondicherry a former French colony. Situated on the coast around 160 km south of Chennai (formerly Madras), it has one of the highest per capita incomes in India. This can in part be attributed to its low tax status which has encouraged a rapid rate of industrialisation and inward migration. The overall geographical area is 29,377 ha of which approximately 30 per cent was devoted to non-agricultural uses (urban and industrial) in 1993/4. The 1991 census recorded a population of 590,000 of whom around 68% lived in urban areas.

Historically most of the region was irrigated from tanks (reservoirs) which filled up during the monsoon season. Shallow wells were used only to provide pre-monsoon water for rice nurseries and land preparation and to supplement surface supplies during dry years (Tank Rehabilitation Project Pondicherry, 1996). However starting in the 1970s, the government heavily promoted the drilling of tubewells, by providing free electrical connections, subsidies for drilling and highly subsidised or free electricity supplies. By the 1990s there were over 7000 tubewells operating in the region resulting in a rapidly falling water table, intrusion of seawater into the groundwater aquifer and falling crop yields. The situation has been exacerbated by rapid increases in withdrawals for industrial and household use in the vulnerable coastal belt.

The Tank Rehabilitation Project, Pondicherry (TRPP) aims to preserve agricultural incomes from crop production in the Pondicherry region, diminish reliance on underground water resources and halt the process of salinisation of the aquifers (Tank Rehabilitation Project Pondicherry, 1996). This is to be achieved through a multi-disciplinary, participatory rural development programme to rehabilitate all irrigation tanks in the region over a seven-year period.

Recognising that these objectives can only be achieved under an appropriate policy framework, a study was commissioned to assess the financial and economic price of surface and groundwater under a range of conditions and to make recommendations for achieving optimal use of these resources. This paper outlines the theoretical framework, research methods and findings of this study before going on to discuss policy options.

2. THEORETICAL FRAMEWORK

The current consensus that water should be treated as an economic good can be dated back to the Dublin statement of the International Conference on Water and the Environment which stated that "water has an economic value in all its competing uses and should be recognized as an economic good" (World Meteorological Organization, 1992).

Briscoe (1996) provides a clear explanation of the theory of water as an economic good. "The idea of water as an economic good is simple. Like any other good, water has a value to users who are willing to pay for it. Like any other good, consumers will use water so long as the benefits from use of an additional cubic metre exceed the costs so incurred ... Welfare is maximized when water is priced at its marginal cost and is used until the marginal cost is equal to the marginal benefit" (Briscoe, 1996).

Ground water has two further characteristics. It is renewable and it is a common property resource. If rate of use exceeds natural replenishment then the water table will fall. As a common property resource it is characterised by overexploitation and dissipation of scarcity rent (Tietenberg, 1996, p. 51). However the precise effects of groundwater exploitation depend crucially on a range of factors. Janakarajan (1993) and Mosse (1996) emphasise institutions, culture and history in their explanations for the decline in tank irrigation. While Shah (1993) points out that tubewell ownership in India is highly skewed and allows owners to extract an economic surplus from what was once a common property resource.

The principles underlying the analysis of water as an economic good, and as a renewable common property resource have been clearly elucidated in the literature. The challenge is to apply these principles to the muddied waters of the real world in order to encourage optimal use of this increasingly scarce resource.

3. RESEARCH METHOD

Primary and secondary data were collected and analysed in order to assess the financial and economic price of surface and groundwater under a range of conditions and to make recommendations for achieving optimal use of these resources. Data collection activities included a baseline survey to provide information for project planning, monitoring and evaluation purposes. It had two components: a detailed study covering agricultural, social and economic aspects of selected tanks and their associated communities and an inventory of all tanks in the region. Data from both components have been used in analysis of the cost and value of water.

The detailed study was carried out in six sample tanks. These were selected based on characteristics such as cropping pattern and intensity, water source, groundwater availability, size of tank, degree of urbanisation, land distribution, etc. Formal survey methods were supplemented by group discussions, discussion with key informants and participatory rural appraisal in order to gain a detailed understanding of the important issues for all stakeholders. Sample strata included water buyers and water sellers in order to be able to compare responses relating to water prices and the prevalence of alternative contracts.

The inventory of all tanks in the region was based on a compilation and review of all existing village level data and brief (1-3 day) visits to all of the 84 tanks covered under the project. This enabled the creation of a database covering selected key variables and a brief profile for all tanks. This covers social, agricultural, economic and technical aspects of the tank, the irrigated area and the communities who make use of these areas.

4. FINDINGS

The findings presented in this section are based on a review of secondary sources and data from both baseline survey components. All prices are reported in Indian Rupees (Rs) and paise (0.01 of a Rupee). In March 2002 the exchange rate was Rs 49 = US$1.

4.1 Financial Cost of Groundwater

The financial cost of water faced by tubewells owners in Pondicherry is in the range of Rs 0.10 - 0.80/metre^3 metre. The wide range reflects the difference in cost between installing a new submersible tubewell and projected maintenance and replacement costs for existing 'mortgage free' wells. The cost of water from these wells is Rs 0.10 – 0.12/metre^3.

Many farmers/cultivators do not own tubewells and depend on purchasing water from private tubewell owners. According to Shah (1993) payment for water in India takes a range of forms as markets become increasingly sophisticated and efficient:

i. labour contracts in which the buyer provides labour and draught power to the seller in return for water;
ii. crop sharing contracts in which the seller provides only water;
iii. crop and input sharing contracts in which the seller provides water and a share of other input costs; and
iv. cash contracts based on area irrigated of a particular crop, price per hour of pumping or per kWH of power used.

Data from the baseline survey indicates that that crop sharing (category ii) is the predominant form of contract in Pondicherry. Most contracts are for a fixed quantity of paddy per area irrigated, rather than for a fixed proportion e.g. one third of the crop. The financial price of water has been estimated based on prices commonly realised by farmers. A selection of estimates of the price of groundwater in local water markets, based on different contract types is presented in Table 1. It may be seen that the cost for paddy varies from Rs 0.70- 1.20/metre^3. Cash payments per hour of pumping are rare and generally more expensive than crop based contracts.

Table 1: Estimates of the Cost of Groundwater Traded in Local Water Markets (paise per cubic metre, 2000 Prices)

Water Cost (Rs/m^3)	Contract Type
1.12	One third of crop
0.70	6 bags per *Khani*, Samba Season
0.75	8 bags per Khani, Navarai & Sornavari
0.93	10 bags per Khani
1.20	Rs 30 per hour pumped (Paddy)
2.60	Rs 65 per hour pumped (Sugarcane)

Source: Baseline Survey.

The ratio of water buyers to tubewell owners is between 2.9 and 4.7 in three of the sample tanks. This is similar to the ratio found by Mathevan Suresh (1996) who studied the water markets in two coastal villages in Pondicherry Region in 1995/6. Suresh presents some interesting data on the effect of well ownership on variables such as production and makes seven generalisations based on his field investigations; all are supported by results from our baseline survey.

- groundwater markets are very localised, each farmer transacting with only a few other farmers;
- the number of sellers is few, and can be expected to drop as falling water tables force deepening of wells;
- unequal access to groundwater and poor bargaining capacity has created a dependent status of water buyers vis-à-vis water sellers;
- most of the water sellers are large land owners and water buyers are mainly small farmers and tenants;
- the frequency of irrigation (which depends on the crop) determines the terms of water transactions – cash or crop share;
- tubewell owners have higher cropping intensity, higher yields and more crops under water intensive crops; and
- water buyers have no rewards or incentives for using water efficiently.

4.2 Financial Cost of Surface Water

The financial cost of surface water (from irrigation tanks and canals) can be calculated by estimating annual surface water use and dividing it by a typical farmer's contribution both in cash and in kind. In Tamilnadu farmer contributions to annual tank maintenance are reported to be around Rs 150 per irrigated hectare per year. Such a level is likely to be below requirements if all regular maintenance works are to be carried out by farmers. Nonetheless it should be recognised that there will be strong resistance to payment of all maintenance costs by farmers. If we assume that farmer annual maintenance contributions in Pondicherry Region will be in the range Rs 150 to Rs 500 per irrigated hectare, then the price of surface water per cubic metre will be Rs 0.02 – Rs 0.05.

4.3 Financial Value of Water

In Pondicherry agricultural water markets exist in most places. Since water is becoming increasingly scarce it can reasonably be assumed that "the price at which water rights are sold more nearly reflect irrigation's productive value to the buyer than its cost to the seller which is often subsidised by the government" (Maass, 1976).

In other words water buyers will be willing to pay close to the value of water in terms of the extra production which they will gain. Water sellers would in theory be willing to sell for as little as their marginal cost of water, but since they face very little competition they are able to appropriate most of the benefits from use of extra water.

Based on this framework, the value of irrigation water can be assessed based on standard 'with/without' project appraisal techniques. This involves projection of net income from an optimal cropping pattern without extra water; and net income from an optimal cropping pattern with extra water. Assuming other factors are held constant, then the difference the between the two (the net benefit) may be attributed to water and a per unit value can be estimated. The value calculated in this way will be an *average* value and will vary depending on the crops grown, productivity and other factors. In Pondicherry the value of irrigation water clearly exceeds Rs 0.70/metre since this is a price that all buyers are willing to pay (see Table 1).

Average value should be distinguished from marginal value i.e. what is the value of one more unit of water. The marginal value of irrigation water is very low or zero at times when farmers over irrigate. It is very high at times of water scarcity, particularly when these coincide with critical stages of plant growth. The value of water also depends on its source and reliability. Tubewell water has the highest value because it is reliable and under the farmers control. Tank water typically has a much lower value because it is less reliable and dependent on cooperation with other farmers.

4.4 Economic Cost of Water

In economic cost benefit analysis, we are interested in the price or return to the whole of society. The price of groundwater faced by tubewell owners does not reflect the real price paid by India as a whole for a number of reasons. The most obvious being that farmers do not have to pay the real cost of the energy which they consume, nor do they have to bear the cost which they impose on others by lowering the groundwater table and causing saline intrusion. The prices and incentives faced by Indian farmers are subject to a complex web of government subsidies, taxes, regulations and controls. In Pondicherry many farmers also receive a package of subsidies covering seeds, fertilisers and agro-chemicals. Assessment of the economic cost of groundwater should be based on the financial analysis but with the following adjustments: electricity should be valued at its economic cost; prices should be adjusted to remove the effect of government taxes and subsidies; and an attempt should be made to assess the cost of groundwater extraction on other users.

One way of measuring the economic cost of electricity in India is through the opportunity cost approach - what is the cost to the country of supplying one extra unit of electricity to rural tubewell owners? Pursell and Gulati of the World Bank (1993)

estimated the long-run marginal cost of power generation and distribution at about Rs 2.9/kwh (adjusted to 2000 prices) and higher than this in rural areas owing to the higher cost of distributing there. They point out that the "true opportunity cost of electricity is best indicated by the cost of generation from the standby generators used by practically all large and medium Indian manufacturing firms. This is usually well in excess of the marginal cost of supplies from the grid."

Private power companies are reported to have entered into long-term contracts with the Government of India to supply electricity to the grid at at Rs 2.45 Rs 2.65 per kwh. While private sugar mills in Tamilnadu are paid Rs 2.48 for supplying electricity to the grid. Assuming a distribution cost of Rs1/kwh this indicates a long run marginal cost of supply of around Rs 3.5/kwh. Indicative analysis of the economic price of groundwater has been based on an electricity price of Rs 3.50 per kilowatt hour, economic values have been adjusted for some major distortions only e.g. the cost of electricity and the cost of drilling.

Based on the above, the economic cost of groundwater is around Rs 1.70 per cubic metre in central and western areas and Rs 0.65-0.85 per cubic metre in coastal areas[2]. This does not include an allowance for the cost of groundwater extraction on other users. The cost of surface water will vary depending on the rehabilitation costs and benefits for individual tanks. For the project as a whole it is expected that rehabilitation will cost Rs 25,000 per hectare of ayacut (irrigated area); this implies an economic cost of around Rs 0.57 per cubic metre.

4.5 Analysis

The financial price of water faced by existing tubewell owners is around Rs 0.10-0.12/metre^3. This is well below the economic cost (usually at least Rs 1.70 /metre^3) because tubewell owners pay only a nominal flat rate fee for electricity. The cost of drilling is subsidised and subsidised loans are often available. Tubewell owners face a marginal cost of water that is close to zero – because of the low flat rate charging system, but because of their market power they are able to extract rent from water buyers of Rs 0.70-1.20 per cubic metre. The owner of a 15 horsepower submersible deep tubewell now pays an electricity bill of Rs 1125/year but may consume electricity with an economic cost of around Rs 70,000 – an annual subsidy to each deep tubewell owner of around Rs 69,000!

[2] these costs are for existing wells where drilling is treated as a sunk cost. Cost for new wells is almost double.

Table 2: Summary of Estimates of the Price and Value of Water (paise per cubic metre, 2000 Prices)

	Financial		Economic
	Price	Value	Cost
Tubewell Owner	10 – 12	>70	170
Groundwater Buyer	70 – 120	>70	170
Surface Water	2 – 5	Less than groundwater	60

Note: These costs are for existing wells where drilling etc is treated as a sunk cost. Cost for new wells is much higher. Value of water depends on use etc. >70 indicates that value is clearly at least 70 paise since all buyers are willing to pay this price.

The existing pattern of ground and surface water use in the region is clearly not optimal at present:

- Tubewell owners pay a highly subsidised flat rate for electricity and so are encouraged to use water in a wasteful manner.
- water buyers (who are generally much poorer than tubewell owners) pay much more than the marginal cost faced by sellers. This results in significant net transfers from water buyers to sellers;
- water buyers generally buy water for a fixed rate per season; so they do not face any incentive for efficient use;
- use of costly groundwater is encouraged at the expense of cheap surface water; and
- there is no effective mechanism to make consumers face the real cost of excessive groundwater extraction in salinisation of the aquifer (and/or forcing other tubewell owners to deepen their wells).

The challenge is to find policies that will ensure that groundwater extraction is kept at sustainable levels and to find ways to efficiently allocate water between different users. The emphasis must be on identification of policies that are realistic within the current political and institutional framework. The following section outlines some of the ideas that were put forward in order to stimulate discussion.

6. POLICY OPTIONS

In theory, the most efficient way of ensuring that consumers treat water as a scarce commodity is to introduce realistic volume based charges. This provides a strong incentive to conserve water and encourages the development of other options e.g. use of tank water (or recycling in the case of industry). Introduction of such charges will require considerable commitment if they are to be effectively implemented in the face of strong opposition.

Ideally all consumers should be metered; this would include domestic drinking water, industrial use, and groundwater for irrigation. In practice the costs of metering small consumers can exceed the benefits so some exemptions may be appropriate. Opposition to metering and realistic water charges is often based on the idea that water is a basic right and so should be provided at a cheap price. One way of reducing any adverse impacts on poor households is through the use of increasing block tariffs. It should also be remembered that the poor generally suffer more than the rich from the failure of policy to address the problems of over-exploitation of the water resource. The problem with projects that aim to introduce water or electricity metering is that the meters often break down or are tampered with. Strong rules will be required if a metering programme is to be effective.

Shah (1993) includes a thorough analysis of the many complex issues relating to public policy and the selection of an optimal system for charging for groundwater. He highlights many of the disadvantages of pro-rata as compared to flat rate tariffs. Under a pro-rata tariff the monopoly position of water sellers tends to be strengthened leading to increasing charges for water buyers. Under flat rate systems this monopoly position tends to be contained and water sellers have very low marginal costs, thus leading to lower water prices. Flat rate systems avoid all of the costs associated with metering and the incentives to pilfer power which strengthen as pro-rata tariffs increase.

Shah (1993, p. 213) concludes that the most equitable method of containing over-exploitation in ecologically fragile areas is through judicious rationing of power supply and moderately high flat rates. The rationed power supply should be of high quality. This implies uninterrupted, reliable power supply supplied on schedules announced well in advance and targeted to periods of peak irrigation needs. Rationing of power supply is reported to be used to control water use (or at least the cost of the electricity subsidy) in Tamilnadu. The design of the distribution system allows the three phase supply to be cut while leaving two phase supply to domestic users unaffected. In Pondicherry it is reported that separate control of the two systems is not possible. However if power rationing is felt to be a worthwhile policy option then it would be worth investigating the cost of modifying the Pondicherry distribution system to allow separate control of three phase supply to tubewells.

Tradable water rights have many advantages as a mechanism for achieving optimal use of limited water resources. They have been used successfully in a number of countries including the USA and Australia. Pursell and Gulati reported that "By far the most promising method of achieving [efficient allocation between users in Indian agriculture] would be to create conditions which would allow the existence of efficient markets in tradable water rights"(1993).

Establishment of a 'simple' regime of tradable water permits in Pondicherry could involve the following main steps:

i. Determine the sustainable level of groundwater use in different parts of the Pondicherry Region (based on groundwater modelling).
ii. Carry out a broad-based consultation process to agree upon an appropriate division of the groundwater resource between agriculture, domestic and industrial use.
iii. Estimate the sustainable number of tubewell connections in each village (based on typical HP and hours of pumping).
iv. Issue this number of tradable permits to holders of existing connections (or based on some other criteria)

Each tradable permit would give the holder the right to one electrical connection in a certain geographic area (probably a revenue village). Use of diesel pumpsets would have to be controlled in order to prevent those without permits from extracting water. If there are too many connections then government would 'buy them back' – at the free market price. If anyone wants a new connection, then they would have to buy one of these permits from an existing holder – at the prevailing free market price. A system would need to be set up to facilitate such transfers. A similar system could be used to work towards optimal use of water by medium and large industry. In this case the tradable permit would give an industry the right to extract a certain volume of water in a certain area. Any new or existing industry wanting to extract more water would have to buy permits from other users. This would mean that industry would face the real cost of water and so would have considerable incentives to invest in water saving technology. It would also mean that industries which rely on large volumes of cheap water would decide not to locate in the region.

7 CONCLUSIONS

The present policy framework is inefficient (it encourages wasteful use of water and electricity), inequitable (it benefits tubewell owners far more than water buyers) and unsustainable (present policies will lead to saline intrusion and a falling water table).

The challenge is to find policies that will ensure that groundwater extraction is kept at sustainable levels and to find ways to efficiently allocate water between different users. The emphasis must be on identification of policies that are realistic within the current political and institutional framework. Three policy options have been discussed; realistic pro-rata power tariffs, power supply rationing and transferable water permits. A broad based dialogue should be encouraged in order to assess these and other policies. One thing is certain, policy improvements will be required if serious environmental and economic effects are to be avoided.

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Agriculture, Irrigation and the Environment: Challenges in Mae Nam Kok Basin, Thailand.

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Abstract

Economic development in Rural Thailand is based in large measure on enhancing agricultural production via the use of irrigation. However, agriculture and irrigation investments often have significant adverse environmental impacts. This paper provides an analysis of these issues for the Mae Nam Kok Basin in Northern Thailand. It identifies and analyses the key agricultural, irrigation and environmental characteristics and problems of this basin. It then presents a framework for future research designed to facilitate sustainable development within this basin.

Keywords: agricultural, irrigation, environment.

Introduction

While there is a growing concern about environmental degradation, in Thailand little progress is made to modify the development process in a manner that will bring in the growing needs of the poor people and to maintain the ecological balance. Thailand, like other developing countries in that the process of economic development is worsening some environmental problems. The crisis in Thailand is more due to the misuse of natural resources like soil, water and forest, than industrialisation (Agarwal, 1986).

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Historically, Thailand was a fertile land and rich in natural resources. At present, the situation has changed. Thailand is faced with a shortage of natural resources, because of the growth rate of population and increasing land use from economic development, especially in agricultural land. However, poverty is still a major cause of environmental degradation in Thailand as in other developing countries. It is like Dearden (1966) stated "because poor people are forced to consume today the resources that should be conserved to provide the necessities of life for future generation".

Modern Thailand had an initial five-year National Economic and Social Development Plan that commenced in 1961. The earlier economic development plans in Thailand emphasized expansion of paddy fields to export rice. This involved construction of irrigation system, especially in the central plain of Thailand because they are suitable for paddy field and the cost for construction is lower than the other parts. But more recently the economic plans – the eighth and ninth National Economic and Social Development Plans – emphasize human development. Consequently, the effect of economic development was per capita income increased due to the GDP (gross domestic product) increasing faster than the population. At present, Thailand is in the first year of the ninth five-year National Economic and Social Development Plan (2002-2006).

The aim of this paper is to describe the situation, problems and alternatives available, which concern agriculture, irrigation and environment in the given basin in Thailand. It is anecdotal in nature to describe the issues, which are currently of concern in watershed management policies. Finally, it will identify fundamental data, which needs to be collected and analysed to increase the effectiveness of watershed management in the future.

Area of Study

Mae Nam Kok Basin is one of the twenty-five basins in Thailand. It is situated in the northern part of Thailand, and covers two provinces: Chiang Rai and Chiang Mai. Population density is sixty-three persons per square kilometre, which is low, because much of the area is still forests and mountains.

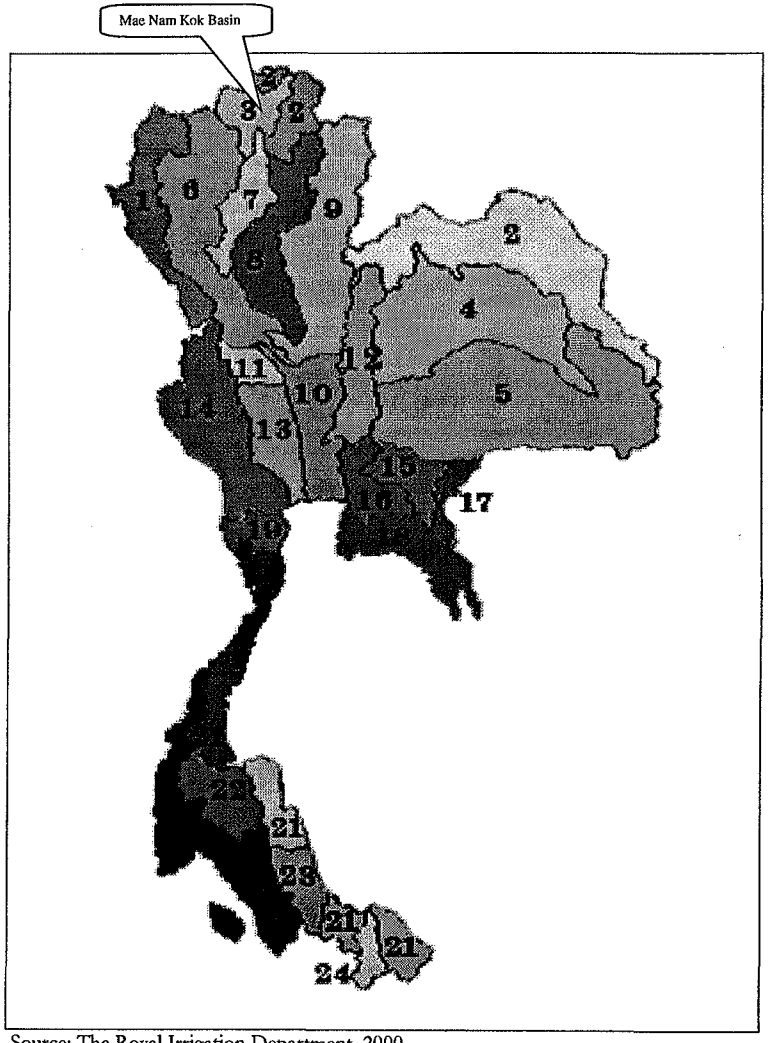
This basin covers 5,750 square kilometres, which comprises two main rivers: Mae Nam Kok (Main River), which covers 2,980 square kilometres) and a lower part of Mae Nam Kok, which covers 2,770 square kilometres (Chiang Mai University, 1994). This river originates in the south part of Chiang Tung in the Republic of Myanmar. Figure 1 illustrates the location of Mae Nam Kok Basin in Thailand.

Chiang Rai, 829 kilometres by road north of Bangkok, covers an area of 11,678 square kilometres. It is the province that is situated at the extreme of north Thailand. To the north, Myanmar and Laos bordered Chiang Rai, and to the south is Lampang and Phrayao province. To the west, Chiang Rai is bordered by Chiang Mai province and Myanmar, and in the east Laos. Chiang Rai is administratively divided into fifteen Districts but the Mae Nam Kok Basin covers only seven districts (Chiang Mai University, 1994).

Chiang Mai, 700 kilometres by road north of Bangkok, covers an area of 20,107 square kilometres. To the north of Chiang Mai, the mountains divide Chiang Mai from Myanmar. This border is about 277 kilometres long. To the east, Chiang Rai, Lampang and Lamphun provinces bordered Chiang Mai. In the south it is bordered by Tak and Lamphun provinces and in the west by Mae Hong Son province. Chiang Mai is

administratively divided into twenty-two Districts but the Mae Nam Kok Basin covers only four districts (Chiang Mai University, 1994).

Figure 1 Location of Mae Nam Kok Basin



Source: The Royal Irrigation Department, 2000.

Agriculture

Rice is a main crop in Thailand, which can be seen from the paddy fields compared with total agricultural land; the paddy field: total agricultural equal 6:10. This section emphasises data on human activities relevant to ecology in Mae Nam Kok Basin, for example, number of farmer, land use, cropping pattern and so on.

The Department of Local Administrator presented the data of year 2000 as shown in this paragraph. Total population in Mae Nam Kok Basin is 775,127 and population density is 103 person per square kilometre, which is lower than the average population density of Thailand – approximately 191 person per square kilometre. The total number of farmers in Mae Nam Kok Basin is approximately 90,000; the number of farmer in Mae Nam Kok Sub-basin is 35,432, which is the highest and the lowest is 11,572, which is in Mae Nam Suai Sub-basin. The detailed data is illustrated in Table 1.

Table 1 The Number of Population and Farmer on Mae Nam Kok Basin

Sub-basin	Province	District	Amount	
			Population (Density)**	Farmer (Per cent)
Mae Nam Kok	Chiang Rai	**Total**	**386,819 (132)**	**35,432 (9)**
		Muang Chiang Rai	211,575 (142)	15,706 (7)
		Chiang Saen*	54,002 (121)	2,400 (4)
		Mae Chan*	72,223 (222)	1,412 (2)
		Doi Luang*	22,372 (72)	1,938 (7)
		Wiengchai	n/a	8,193
		Wiengchiangrung*	26,647 (128)	5,783 (22)
Mae Nam Fang	Chiang Mai	**Total**	**210,211 (120)**	**27,343 (13)**
		Fang	102,415 (125)	13,253 (13)
		Mae Ai	62,409 (98)	7,537 (12)
		Chai Prakan	45,387 (87)	6,553 (14)
Mae Nam Lao	Chiang Rai	**Total**	**103,095 (80)**	**16,406 (16)**
		Mae Lao	32,305 (146)	3,738 (12)
		Wiengpapao	70,790 (66)	12,668 (18)
Mae Nam Suai	Chiang Rai	**Total**	**75,002 (56)**	**11,572 (15)**
		Mae Suai	75,002 (56)	11,572 (15)
	Total		**775,127 (103)**	**90,753 (12)**

Source: The Department of Local Administrator, 2000.

Note: * The number of farmer is for some sub-district existing in sub-basin, but the data of population is for the whole sub-district.

** density = person per square kilometre

n/a = data not available

Farmers in Mae Nam Kok Basin are like the farmers of all parts of Thailand that grow rice as the main crop in rainy season. The total agricultural area in Mae Nam Kok Basin – Crop Year 2000/01 is 812,048 rai (324,819.2 acre) and they grew rice on approximately

508,285 rai (203,314 acre) or 63% of total agricultural land. However, they grew fruit tree (Longan and Lychees) in a large amount approximately 70,000 rai (28,000 acre) or one-elevenths of agricultural land. The detail of land use is shown in Table 2.

Table 2 Land use in Mae Nam Kok Sub-basin crop year 2000/01

Unit: Rai

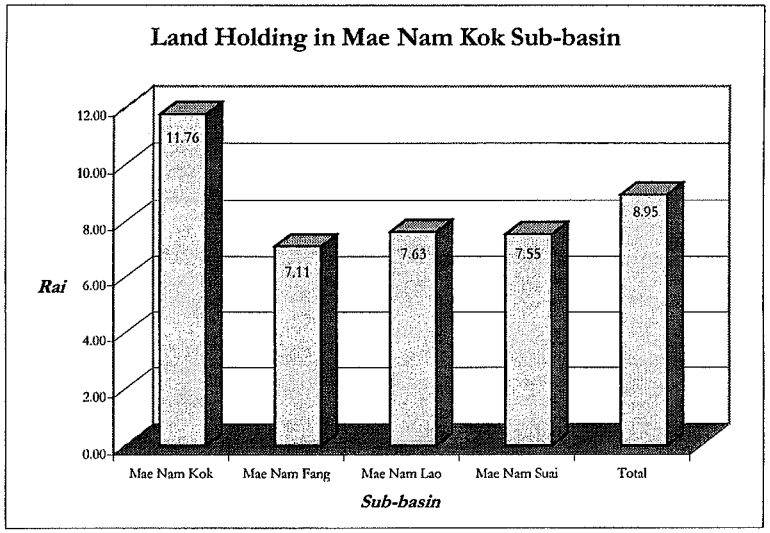
Crop	Mae Nam Kok	Mae Nam Fang	Mae Nam Lao	Mae Nam Suai	Total
Rice - Rainy	294,954	107,960	78,602	26,769	508,285
- Dry	11,195	1,280	3,021	5,411	20,907
Maize	72,846	4,210	38,625	50,142	165,823
Cassava	16,681	-	283	-	16,964
Soya bean	285	2,100	-	1,447	3,832
Ground Nut	513	380	370	-	1,263
Onion	-	16,291	187	-	16,478
Shallot	16	2,420	30	-	2,466
Garlic	364	20,040	813	965	22,182
Potatoes	5	3,010	867	-	3,882
Longan	19,063	6,470	5,433	7,824	38,702
Lychees	-	31,480	-	-	31,480
Coffee	321	-	10	272	603
Total - Rainy	**405,048**	**194,361**	**125,220**	**87,419**	**812,048**
- Dry	**11,195**	**1,280**	**3,021**	**5,411**	**20,907**

Note: 1 Acre. Equal 2.5 Rais.

Source: The Office of Agricultural Economics, 2002.

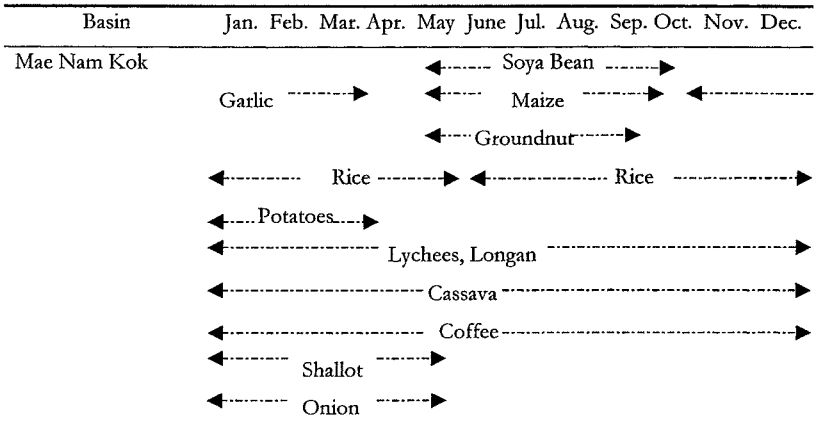
From Table 1 and Table 2, it can be calculated the land holding of farmers in each sub-basin, which the result is shown in Figure 2. The land holding in Mae Nam Kok Basin is approximately 8.90 rai (3.56 acre).

Figure 2 Land Holding in Mae Nam Kok Sub-basin



In Mae Nam Kok Basin the farmer grows rice in rainy season and it is the main crop. They plant in early of May and harvest in October of that year, if they have enough water – it means that they live in the irrigated area – they will grow rice again. However if they have inadequate water for rice they will change to another crop for example, garlic, onion, shallot and so on. The details of calendar is shown in Figure 3; and the cost, farm gate price and yield is shown in Table 3.

Figure 3 Cropping Pattern in Mae Nam Kok Basin



Source: Office of Agricultural Economics, 2000.

Table 3 Cost, Farm Gate Price and Yield in Mae Nam Kok Basin Crop Year 2000/01

Crop	Total Cost	Farm Gate Price *	Yield *	
			Chiang Rai	Chiang Mai
Rice – Rainy	n/a	4.665	461	517
- Dry	n/a	4.241	675	643
Maize	1,381.49	3.79	669	527
Cassava	n/a	0.63	2,128	2,128
Soya bean	1,836.17	9.23	221	252
Ground Nut	1,969.60	11.24	268	249
Onion	n/a	11.88	2,084	4,128
Shallot	10,640.00	15.01	1,904	2,042
Garlic	13,860.00	22.38	860	98
Potatoes	n/a	n/a	2,768	2,768
Longan	4,800.00	26.17	1,009	1,115
Lychees	n/a	34.50	n/a	733
Coffee	6,219.17	42.00	159	n/a

Source: Office of Agricultural Economics, 2002.

Note: * represented for average for crop year 2000/01.

Farmer income in Mae Nam Kok Basin comes from rice surplus to household consumption and income from cash crops – coffee, cassava, groundnut, garlic, maize, and fruit – longan and lychees. In addition, they earn some money from temporary labour, carpentry, and profit from miscellaneous sales, salary and so on. Household income of the population in Chiang Rai and Chiang Mai was 25,206 and 45,614 baht per household respectively.

Expenditure of the farmer is separated into two parts, first is the expenditure in on-farm – fertiliser, pesticide, herbicide, fuel, hired labour and so on. Second part is the expenditure off-farm – food, clothes, entertainment and so on. However, when the farmer subtract all expenditure from all income they have some money to keep for the next year but it might not enough so they will borrow from the other people or institute such as relatives, agricultural bank and farmer groups.

Irrigation

Most irrigation in Thailand is gravity irrigation. The Royal Irrigation Department (RID) divide all of the irrigation projects into three types: large scale irrigation project, medium scale irrigation project and small scale irrigation project, which are depended on the volume and capacity of water. The types of irrigation projects are defined as follows (Royal Irrigation Department).

> … In general, a large scale irrigation project shall be a project implemented for multi-purpose benefits including agriculture, domestic consumption, industrial use, electricity generation, inland navigation, fish culture, and recreational area and so on. To achieve such purposes, the project can be constructed in various forms, for example, storage dam; diversion dam or weir; pumping; distributing or drainage system and on-farm irrigation system. In brief, a storage dam shall be determined as a large scale project, if it is by 1) a reservoir of over 100 million cubic metres retention characterized

capacity, or 2) the impounded water surface of over 15 square kilometres or 3) at least 12,800 hectares commands areas.

Medium scale irrigation projects are the projects that are smaller than the large scale irrigation projects in the following criteria: storage volume less than 100 million cubic metres; surface area less than 15 square kilometres or irrigation area less than 12,800 hectares.

With an aim to lesson the people's difficulties in water mainly for their domestic consumption and cultivation, the Royal Irrigation Department has initiated the development of small-scale irrigation project since 1977. Under this type of project, small-scale structures would be constructed according to the local topographical features so as to solve the problem shortage, flood and saline water intrusion.

The irrigation area in Mae Nam Kok Basin is 663,788 rai (265,515.20 acre) or 82% of total planted area, which can divide into three types as definition above. However, there are only two large-scale projects in the basin, which have been developed by the Royal Irrigation Department (RID) and the Department of Energy Development and Promotion (DEDP).

The first project called Mae Lao Weir was built up for more than 50 years ago by RID. It is situated between Muang Chiang Rai and Phan District in Chiang Rai Province. The water surface is about 2,700 square kilometres, behind a weir made of concrete about 2.50 metres height and 30.50 metres long. The irrigation area in Mae Lao Weir is about 166,000 rais (66,400 acre) (Chiang Mai University, 1994). At present (2001-2004), Mae Lao Weir has a project loan for an agricultural restructuring programme: the development of farmers whose is in the irrigation zone and natural water reservoir area. Agricultural products including crops, livestock farming and fisheries will be promoted for a better quality and suitable to the potential area (Cabinet Synopsis, 2001).

The second project has been developed by the DEDP in 1990. The project is called Chiang Rai Weir, which is situated at Paa Yang Mon (village) in Muang Chiang Rai

District. The Chiang Rai Weir is a concrete weir with 11 drainage doors. The water surface of the Chiang Rai Weir is about 6,220 square kilometres and irrigation area is about 70,700 rais (28,280 acre) (the Office of Agricultural Economics, 1994). The figure in Table 4 is shown the irrigation projects in Mae Nam Kok Basin.

Table 4 Irrigation Projects in Mae Nam Kok Basin, September 2000.

Agency	Characteristic of Project	Number	Benefit Area (rais)
RID	Irrigation Project	122	459,172
DEDP	Electric Pumping Project	14	20,440
	Chiang Rai Weir	1	70,700
DRRD	Shallow Well Project	8	13,704
DOLA	People's Irrigation Project	133	99,772
	Total	**278**	**663,788**

Source: The Royal Irrigation Department, 2001.

Environment

Environmental degradation in Mae Nam Kok Basin is relatively complicated. Just like Berry (1988) stressed, "People may invest in meanings as well as in the means of production – and struggles over meaning are as much a part of the process of resource allocation as are struggles over surplus or the labour process". Historical patterns of access to resources and exclusion from them mould cultural understandings of rights, property relations, and entitlements; in turn, these competing meanings influence people's land and resource use (Shipton, 1994; Watts, 1991). Struggles over cultural idioms and access to resources reveal salient gendered differences along with those of class (Agarwal, 1994; Mackenzie, 1995).

The development of the agricultural productions in Mae Nam Kok Basin took place in the context of no enforcement of regulation over the environment. The growth of the agricultural productions created two main types of environmental problems: effects that stay within the basin and effects that cross outside the basin. This paper focuses on effects that stay within the basin.

Problems which stay within Mae Nam Kok Basin includes forest destruction from two main causes: the increase of population and the shifting cultivation practice. Moreover, the expansion of agricultural area for rice in the last two decades came largely due to land scarcity. So, the farmers adopted more intense cultivation practices: new varieties, irrigation, pesticides and fertiliser. Additionally the depletion of forest area is one of the causes of more erratic rainfall during the last few years which made water management and irrigation an important factor for the development of agricultural productions.

Consequently, there is much irrigation in this basin but it is not enough water supply for consumption because human does not need water only in agricultural supply but they need it for other aspects for example; urban water supply, industries and energy. These causes effect to a shortage of natural resources and water supply especially in dry season.

The shifting cultivating practice in Mae Nam Kok Basin is the cause of degradation of agricultural ecology. The problems are soil fertility, soil structure, more insect and disease, soil erosion and siltation. Moreover, the fishermen have exhausted that fish species in natural water resources have severely depleted in quantity and some distinction because of there are negative externalities effects from agricultural land that flow through the rivers and water sources.

Framework for Future Research

The planned research will determine the appropriate methodology use of fundamental data that exists for the basin. The new methodology has to provide information which helps alleviate poverty today and provide a sustainable environment for the future. To achieve this goal the best approach is watershed management because it sees rivers in their entirety or at the watershed level.

Useful analysis of watershed management in Thailand requires collection of some new data in the given area. The data, to be collected in the basin, is in four main categories. First, the cost and benefit of the government that invested in construction dams, reservoirs and weirs. Second, the cost and benefit the farmers, is received from the new development. Third, the cost and benefit of the farmers who did not receive benefit from the development. The last is the cost and benefit for the environment affected by the development.

After collecting all data that is described above it will be used in Benefit-Cost Analysis. Cost and benefit in the given area will be analysed to find out the appropriate management strategies to implement in the basin. Benefit-Cost Analysis is useful for analysis because it easy to use and will show your all costs and benefits associated development. However it is possible some data can not be collect for analysis (for example the value of scenery).

Conclusion

The key challenge is to structure the analysis so that data can be straightforwardly be used by government agencies seeking to evaluate public investments in a credible and

timely manner. The development of agricultural production and irrigation in Mae Nam Kok Basin has depleted the supply from natural resources – forest land, water, and soil. The depletion of natural resources will slow down the growth in agricultural productions and it has costs for agriculture in the future. Currently environmental policies are not eliminating the environmental damage. Given increasing agricultural production goods and significant competition in the market, it is essential to find a suitable methodology to enhance watershed management in the Mae Nam Kok Basin, and among other basins in Thailand.

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NCARES Conference 2002.

Environmental Taxation: The European Experience

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Abstract

Environmental taxation is a key component of many green politicians' views of a more sustainable eco-economy. Environmental taxes have long been used in Eastern Europe and in the last decade have been used extensively in Western Europe. This paper documents the use of environmental taxes in Europe, classifies them, evaluates their impacts and analyses their significance in Europe. It then provides some interpretation as to what this experience means for New Zealand, Australia and the United States who to date have not developed the same enthusiasm for environmental taxes.

Environmental Taxation: The European Experience

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1.0 Introduction

1.1 Energy and fuel taxes

In 1991, many nations of the world met to discuss global environmental problems at the Rio de Janeiro Conference on Climate Change (also called the "Earth Summit"). There, they determined that one of the primary threats facing the human race is that of the global climate change caused by global warming. One of the causes of global warming identified was the emission of so-called greenhouse gases from industrial processes. The Rio Convention on Climate Change included an agreement to reduce significantly the emission of greenhouse gases by all parties to the Convention, which the EU has been since December 1993. The method chosen by the EU was a discussion on a possible tax on energy, and CO_2 emissions directly. While some members of the EU have come up with plans to reduce their production of CO_2, several of which involve such a CO_2 tax (Germany, Belgium, Italy, Luxembourg, Denmark, and the Netherlands) others have opposed the tax on various different grounds, including lesser industrialization and energy use and infringement of national sovereignty.

After the Rio Conference, discussion on the introduction of energy tax at EU level escalated. It was considered an appropriate and effective means of combating the greenhouse effect, by spurring towards eco-efficiency the innovation and production patterns in business in particular, but also the consumption patterns of society in general.

It is common knowledge that the lack of a harmonised energy taxation system in the European Union is causing problems in its liberalising energy market, distorting competition among member countries and complicating the effort to meet the environmental targets of the Kyoto protocol[1].

1.1.1 Taxes on motor fuels

The taxation of motor fuels has a long tradition in the countries mentioned above. For example, in Norway excise taxes on motor fuels were introduced in 1931, and taxes on petrol have existed in Denmark since 1917. Energy taxes are the biggest revenue raisers among environmental taxes.

There are big differences in the tax rates of motor fuels between the EU Member States plus Norway and Switzerland. The highest taxes can be found in the UK and the lowest tax rates in the Cohesion countries. The gap between unleaded petrol and diesel/gas oil has not narrowed in many countries. The comparison between the tax rates of unleaded petrol and diesel/gas oil shows that, among Western European countries, only Switzerland has introduced a higher tax rate for the latter, which better reflects their respective negative environmental impacts. This is also true for the UK if the tax rate for conventional diesel is compared with the tax rate for unleaded petrol. However, the majority of diesel sold in the UK is ultra low-sulphur diesel for

[1] *European Union: Energy-tax farce*, Petroleum Economist; London; March 2001

which the tax rate is reduced and lower than the rate for unleaded petrol. Most countries maintain relatively low tax rates on diesel out of concern for their road transport industries[2].

A quite interesting development regarding the tax rates on motor fuels in the 15 EU Member States plus Norway and Switzerland emerges from comparing their development between 1997 and 2001. The tax rates in some of these countries have been kept constant and changes can only be attributed to changes in the exchange rate ratios between the individual national currencies and the Euro[3]. For example, the tax rates for motor fuels have not changed in Austria and the reduction in the tax rates is the result of changes in the exchange rate between the Austrian shilling and the Euro. The biggest percentage increase in the tax rates for motor fuels (petrol leaded, petrol unleaded and diesel) over the last three years occurred in the UK (see Table 4). The increases amount to 44%, 44% and 41% expressed in Euro. Table 3 also shows quite big increases in the tax rates for the Netherlands, Denmark and Germany. On the other hand quite high reductions in the tax rates are found in Greece and Portugal, although parts of these changes are due to the changes in the exchange rates between the Euro and the national currencies.

Table 1: Percentage changes in tax rates between 1997 and 2001 for different energy products in EU Member States plus Norway and Switzerland (unit: %)

	Petrol leaded	Petrol unleaded	Diesel	Gas oil (industry use)	Heavy fuel oil
Austria	-0.5	-0.5	-0.5	-0.5	-0.5
Belgium	-4.5	-3.3	-0.6	-0.6	-66.9
Denmark	13.5	16.2	7.6	13.3	14.3
Finland	3.2	4.0	6.0	27.8	42.0
France	2.0	2.3	9.7	2.8	6.9
Germany	10.5	11.6	18.7	49.2	16.0
Greece	-16.3	-9.3	0.5	0.5	-6.7
Ireland	4.4	-13.8	-0.3	-5.2	-5.2
Italy	-0.5	1.3	3.1	3.1	35.4
Luxembourg	5.5	6.4	-0.6	-0.6	-0.6
Netherlands	11.6	12.7	10.4	62.5	96.4
Norway	3.0	3.1	6.2	-11.1	-33.5
Portugal	-3.2	-25.3	-7.4	-7.4	-55.6
Spain	2.4	2.4	2.4	2.4	2.4
Sweden	-0.7	-0.7	8.0	-0.7	1.4
Switzerland	5.4	5.5	4.4	4.4	4.4
UK	43.7	43.7	41.6	43.8	61.6

In 9 of the 17 analysed countries the tax rates increased for these three motor fuels and in 4 these rates decreased. In the other 4 countries there was a mixed result. For example, Sweden increased the tax rates for diesel in the Budget 2001 and kept the rates for petrol constant.

Table 2 illustrates the differences in taxes on motor fuels applied in EU Member States plus Norway and Switzerland by normalising the tax rates with regard to the

[2] European Environment Agency: *Environmental taxes: recent development in tools for integration*, D.Jimenez-Beltran, Copenhagen November 2000.

[3] Euro - On 1 January 2002 euro cash was introduced in the twelve countries of the euro area. The dual circulation period has now ended in all the euro area countries and the former national currencies are therefore no longer legal tender.

UK tax rates; i.e. setting the UK tax rate equal to 100. Taxes levied on motor fuels are the highest in the UK, followed by Norway. Low taxing countries are mainly the cohesion countries (Greece, Ireland, Portugal and Spain) and Luxembourg. The differences in the tax rates are very marked for diesel: the diesel tax rate for 8 EU Member States is less than 40% of that in the UK. The gap between the UK and lower taxing countries such as Austria, Greece, Portugal, Ireland and Spain was substantially increased by the road fuel duty escalator, and is now largest with respect to Greece, where the tax rates for unleaded petrol (diesel) are only 42% (33%) of the tax rates in the UK.

In the Netherlands the tax rates on all energy products have now been indexed to inflation. Italy reduced the tax rates of its recently introduced CO_2 taxes on motor fuels during 1999, because of the oil price rise. This measure was part of an anti-inflationary policy implemented by the Italian government keeping inflation in line with the Maastricht Stability Treaty. The reduction was extended into 2000. Following the decision by the Organisation of Petroleum Exporting Countries (OPEC) to increase crude oil production in order to reduce the world price of oil, and an increase in Italian petrol consumption, the Italian government re-introduced the carbon dioxide tax in June 2000. Similar policy measures aiming to curb inflation, but which are likely to have negative environmental effects, can be found in Spain which cut the subsidy programme for renewable energy sources and reduced motorway taxes.

Table 2: A comparison of taxes levied on motor fuels (shown in terms of the highest tax rates by setting the tax rate applied in the UK equals 100).

	Petrol leaded	Petrol unleaded	Diesel
Austria	55%	52%	37%
Belgium	63%	63%	38%
Denmark	69%	66%	45%
Finland	73%	72%	42%
France	72%	75%	51%
Germany	70%	72%	49%
Greece	39%	42%	33%
Ireland	52%	48%	42%
Italy	66%	69%	53%
Luxembourg	48%	48%	33%
Netherlands	75%	76%	45%
Norway	83%	83%	67%
Portugal	55%	45%	32%
Spain	46%	48%	352%
Sweden	68%	66%	48%
Switzerland	57%	58%	61%
UK	**100%**	**100%**	**100%**

Several EU Member States have tax differentiation based on the technical characteristics of motor fuels. These are very common in respect of leaded and unleaded petrol. Differentiation according to the sulphur content in the fuels has been introduced by EU Member States such as Sweden and the UK, and is in the pipeline in Germany.

All Central and Eastern European Countries aim to join the European Union. Croatia has implemented excise taxes on the three main motor fuels (leaded petrol, unleaded petrol and diesel). However, excise taxes on other motor fuels, such as LPG and kerosene, are only introduced in a small number of the countries in the region; for example the use of LPG for transportation is subject to an excise tax in the Czech Republic, Estonia and Slovakia. Hungary and Slovenia have the highest excise tax rates for motor fuels and these rates are in line with EU minimum excise tax rates. The lowest taxes levied on motor fuels can be found in the three most northern countries – Estonia, Latvia and Lithuania – as well as in Bulgaria and Romania. The tax rates in the other four countries, Czech Republic, Poland, Slovakia and Croatia, are in the middle of the range. It should be noted that leaded petrol is not for sale in Hungary, Lithuania and Slovakia. As mentioned above, Slovenia is the only country in the region that has introduced a CO_2 tax on fuels. Moreover, in Slovenia diesel is taxed higher than unleaded petrol.

Excise taxes for motor fuels in all CEEC aiming to join the EU except Hungary and Slovenia are below the EU minimum rates, these tax rates will need to be increased. This may cause problems of affordability and social exclusion, because in some of these countries prices for motor fuels have already reached almost the same level as in some in EU Member States.

1.1.2 CO_2 and SO_2 taxes on the basis of Nordic countries and CEEC

Taxes on energy products other than motor fuel are becoming increasingly important in Europe. They often form part of an Ecological Tax Reform. Thus their main function is fiscal, but they also have important incentive functions.

CO_2 taxes were introduced in some EU countries (Denmark, Finland, Germany, Italy, the Netherlands, Sweden, France and the UK) and in Norway and more countries plan to do so (Belgium, Luxemburg).

A couple of evaluation studies have been done in the Nordic countries.

The **Danish** CO_2 taxes have probably contributed to the fact, that since 1986, energy consumption has remained fairly constant and emissions have decreased, whereas real GDP has grown by more than 50%. It has been assessed that the energy policy package introduced in 1995 will reduce CO_2 emissions by 3.8% by 2005, of which 2% will be realised as an impact of the taxes.

The Danish tax on the sulphur content of energy products, introduced in 1996 has had a rapid impact. The average sulphur content of fuel oil and coal (and thus SO_2 emissions) decreased significantly in the same year. In addition, the tax had a positive impact on the development of sulphur purification plants and technology[4].

In **Sweden**, the introduction of the CO_2 tax in 1991 was estimated to have led to a reduction in carbon dioxide emissions of 5 million tonnes by 1994, representing 9% of total Swedish CO_2 emissions. However, following a reduction in this tax rate in 1992, CO_2 emissions were found to have increased. In total, in 1995 and 2001 the tax rates were doubled for industry.

The Swedish tax on sulphur is estimated to be responsible for 30% of the total reduction in sulphur emissions from 1995 to 1998.

[4] Danish Ministry of Taxation

The CO_2 tax in **Finland** is among the highest in Europe. The tax was introduced in 1990. Without the impact of energy taxation, emissions would have been 4 million tonnes, i.e. a 7% higher than the 57 million tonnes recorded in 2000.

In **the Netherlands** the "regulatory energy tax" was introduced in 1996 and has not yet produced measurable environmental impact. However, it has made energy conservation investments more attractive for firms, leading to shorter payback times and increase in the amount of profitable energy-saving options by about 5%. It has also stimulated the use of renewable energy.

One of the most controversial issues in energy taxation is the complete exemption of aviation fuel for commercial aircraft from excise taxes because international treaties disallow such taxation. Some environment-related taxation exists in air traffic because several EU Member States as well as other European countries have introduced aircraft landing charges depending on noise levels or other environmental related classifications of aircraft. Norway introduced a carbon dioxide tax on aviation fuel in 1999 but was soon forced by international pressure to exempt international airlines from it.

Central and Eastern European Countries have previous experience with emission charges, as pollution charges and penalty rates, the so-called non-compliance fees, were introduced in many countries as early as the 1970s. While serving no economic function, during this period, these charges were modified during the transition to a market-based economy in many countries. Table 3 gives an overview of some emission taxes in CEEC. The development and implementation of air pollution charges, the primary pollutants being SO_2, NO_X, and solid particles, varies both in comprehensiveness and success throughout the region. On a regional basis, more attention has been given to the revenue-raising function of economic instruments rather than their ability to provide incentives to polluters to reduce environmental pollution. This can be attributed to budgetary pressures in most countries, which have severely restricted the public financing of environmental investments. The revenues generated from these charges are earmarked for environmental funds in most countries. Moreover, much experience had been accrued within environmental ministries regarding these types of charges because of the potential for environment-related financial support from earmarked funds that makes these charges often more politically attractive. For this reason, economic instruments have now become the main revenue source for state or municipal environmental funds which exist in most countries in the region. SO_2 and NO_X charges have been regularly introduced in conjunction with a permit system in CEEC: a base charge rate is applied to all pollution within the permitted level and a penalty rate is added for pollution above that level, i.e. the non-compliance fee. Large point-source polluters (combustion plants, heavy industry) are the primary subjects of these instruments. The charges are intended to raise revenues and encourage cost-effective abatement below the permitted level. The fines, i.e. non-compliance fees, are intended to provide an incentive to reduce pollution to permitted levels and therefore play a compliance function. Such systems are in place in Poland, Czech Republic, Estonia, Latvia, Lithuania, and Slovakia. As noted above, the revenues from these charges and fines are largely earmarked for expenditure through national and regional or local environmental funds[5].

[5] On the basis of: J. McNicholas and S. Speck 2000, *Taxation on Energy and Transport: Domestic Policies in the Context of Climate Change in Central and Eastern Europe*, REC, Szentendre.

Table 3: Overview of Selected Emission Taxes/Charges in Selected European Countries (2000).

Country	EUR per tonne SO_2	EUR per tonne NO_X	EUR per tonne CO_2
Accession Country*			
Czech Republic	28 (EC) 42 (NC)	22 (EC) 33 (NC)	
Estonia	3.52 (EC) 35.2 (NC)	8.5 (EC) 80.5 (NC)	
Poland	85 (EC) 850 (NC)	85 (EC) 850 (NC)	
Slovakia	22.7 (ET)	18.2 (ET)	
Slovenia			14 (PT)
EU Member States			
Finland			17.1 (PT)
France	27.4 (ET)	38.1 (ET)	
Italy	53.2 (ET)	105 (ET)	
Sweden	3,470 EUR/tonne S	4,630	42.8 (PT)

Source: REC 2001

Notes: (ET) - Emission Tax; (EC) - Emission Charge; (NC) - Non-compliance fine per unit emissions above permitted levels; (PT) - Product Tax.
* Revenues from emission charges and fines in Czech Republic, Poland, and Slovakia are earmarked for environmental expenditure via national or regional environmental funds. Estonia earmarks revenues within the central budget.
Slovenia - liquid fuel tax based on carbon content of fuel
Sweden - the tax rate for the sulphur tax presented above is for coal and other solid fuels.

1.2 Transport – influence on the air quality

Although air quality in Europe, and particularly in the large urban areas, has improved in recent decades, nearly all urban citizens still experience infringements of the limit values. About 90% of the urban population experience it of both the 24 h and annual average EU objectives for particulate matter[6]. Exposure to exceedances of NO_2, benzene and ozone are also frequent. The transport sector is a major source of air pollution, and the dominant source in urban areas, having overtaken the combustion of high-sulphur coal, oil and industrial combustion processes. Within the transport sector, road traffic is the most important contributor to urban air pollution. While national and EU regulations aimed at automobile emission reductions (such as the

[6] OECD Publication: *Motor Vehicle Pollution: Reduction Strategies Beyond 2010* (II), London 2000

introduction of catalytic converters or unleaded petrol) have resulted in considerably lower emissions per vehicle, the continuous expansion of the vehicle fleet is partly offsetting these improvements[7].

In addition to fuel taxes, Member States apply various other transport taxes and charges: taxes associated with buying, hiring, and registering a vehicle (e.g. VAT and registration taxes), other taxes payable in connection with the possession or ownership of a vehicle (circulation taxes and insurance taxes), taxes directly or indirectly related to the use of vehicles. Vehicle-related taxes generate the second highest revenues of all environmental taxes. Existing taxation in this area is very complex because the systems implemented in the EU Member States can be both complex in themselves and quite different from country to country.

Some of the EU countries levy *the purchase or registration of a new motor vehicle* tax. The purchase or registration taxes are lower for "cleaner" cars.

Annual motor vehicle taxes are levied throughout Europe, again with a mainly fiscal purpose. Common tax bases in this case are weight and engine capacity, favouring cars with relatively low fuel consumption. For example, in Denmark the basis for the tax of vehicles registered after January 1997 is fuel economy, in Germany the tax base of the annual vehicle tax depends on cylinder capacity, engine power and emissions. The UK Government also moved in this direction introducing in March 2001 a new system of vehicle excise duties (VED – the annual vehicle tax) for new cars and the primary basis for the VED is CO_2 emissions. Diesel cars, which are relatively polluting but energy-efficient, are usually taxed at a higher rate than petrol cars. However, excise taxes on diesel are lower[8].

A differentiation in the rates of annual motor vehicle tax according to emission characteristics and energy use can be expected to have a positive environmental impact. Lower or zero rates are sometimes applied to cars with electric engines, but such cars are still exceptional in Europe.

New developments in the context of vehicle-related taxes can also be reported in respect of road pricing. Road pricing has been on the political agenda for some years and Norway has already introduced road pricing for driving into cities, such as Oslo, Bergen and Trondheim, on a large scale. Further pricing schemes in Norway are in the planning stage. Such schemes are also being tested elsewhere, such as in York and Edinburgh in the UK.

The 'Eurovignette' scheme implemented in eight European countries is levied on heavy good vehicles. However, more and more countries are planning to introduce road pricing for trucks that would take the place of the 'Eurovignette' scheme. The German government has announced that such a scheme will be introduced by the end of 2002, and would be based on the distance driven by trucks. The proposed rate is 0.13 EUR per km driven compared to rates of 0.14 EUR per km driven in France, and 0.1 - 0.15 EUR per km driven in Italy.

[7] Since 1970, the number of passenger cars in the EU has increased by a factor of 2.5, an average of 3.4 % per year. Between 1970 and 1997, the growth in the number of passenger cars was highest in Greece (8.4 % per year), Portugal (6.9 % per year) and Spain (6.6 % per year). These countries had by far the lowest numbers in 1970. The Member States with the lowest growth were Sweden (1.5 % per year), Denmark (1.7 % per year) and the United Kingdom (2.3 % per year).
[8] OECD publication: *Environmentally Sustainable Transport: Futures, Strategies and best Practice*, Vienna, October 2000.

In the CEEC the situation concerning environmental taxes in this area is similar to that in EU Member States. Transport-related taxes are very common in these countries, although these tend not to be based on environmental criteria (such as setting the annual vehicle tax according to emissions or according to fuel consumption). Road pricing in the form of highway tolls is very common in the region and the revenues are generally earmarked for infrastructure measures. Seven of the ten EU Accession Countries have import duties and sales taxes for vehicles. The rates of the import duties are set according to the age of the vehicles in several countries; i.e. older vehicles are levied with a higher tax rate.

1.3 Water related taxes and charges

1.3.1 User charges for water consumption and sewage treatment

A comprehensive comparison of user charges for water consumption and sewage treatment is almost impossible to carry out for several reasons. The biggest obstacle to such an analysis is the fact that such charges are levied at the regional or municipal level and are usually administered by public or private companies. However, the price level is regularly controlled by a public body. For example water companies are completely privatised in the UK but the water regulator, the Office of Water Services (OFWAT), announced price cuts for water charges that have to be implemented by the private water companies[9].

User charges for water are set in a wide variety of ways in different EU Member States. One of the reasons lies in the fact that water metering of household usage of water is still not widespread in different countries. Currently in Europe the water bill can be based on the value of the property (parts of the UK – Scotland and Northern Ireland), on the area of the house (Norway) or on a combination of a flat fee and variable charging. Special tariff settings such as increasing block tariffs are also applied in some countries, for example in cities such as Athens, Barcelona and Zurich. In Ireland there is still a unique situation where domestic consumers pay nothing for water supply and wastewater treatment, because the costs for these services are part of local taxation. Water services, like provision of drinking water and wastewater treatment, are subject to VAT. But the VAT rates applied in the different countries differ in the sense that some countries levy the standard VAT rate on the user charges (for example, Sweden, Denmark and Finland) compared to a reduced VAT rate in other countries like Belgium, Germany and France[10].

1.3.2 Water taxes

Water taxes are quite complex and difficult to compile and also to analyse because of the different water management policies adopted in the EU Member States; i.e. the responsibilities of water management varies between the Member States. Therefore a few of the most important examples will be discussed.

The Netherlands tax on ground water introduced in 1995 was expected to reduce groundwater use by between 1.3 and 51.0% depending on the type of user. In 1997, a first evaluation showed that water savings by industry were developing in line with expectation, whereas small-scale groundwater extraction by households and

[9] Pearce, D., Seccombe-Hett, T. & Turner, R.K. 2000 Market-Based Instruments in the United Kingdom: Consultancy to Support Work on Modernising the Economy, Report for the UK Round Table on Sustainable Development, April, Department of the Environment and the Regions, (DETR), London.

[10] OECD (Organisation for Economic Co-operation and Development), Agricultural Water Pricing in OECD Countries II, Document ENV/EPOC/GEEI11/FINAL, Paris 2001.

agriculture were increasing. The Netherlands introduced a new tax on water supply in 2000. The tax is levied on water delivery of up to a maximum of 300 m^3 per connection per year and the aim of the tax is to give a price signal for water saving. Apart from the Netherlands only Denmark has implemented this type of tax so far, in 1994, with only households subject to the tax payment. The Portuguese government announced that it would probably introduce its water tax by 2004. The tax will apply to all consumers, whether they are householders or businesses and will probably be set at 0.025 euros (£0.015) per cubic metre[11].

The situation looks quite different if water effluent taxes are studied. These types of economic instruments are in widespread use in EU Member States. For example, Germany has levied a water-effluent charge since 1981, applied to the discharge of toxic substances into water. Some pollutants are taxed more heavily than others, based on their perceived dangers[12]. Water effluent taxes have not yet been introduced in Austria, Norway, Portugal, Greece and in Switzerland (see Table 1).

The use of water abstraction taxes is widespread also in CEEC. 8 out of the ten EU Accession countries in the region have implemented this type of economic instrument. Table 4 below gives information concerning their taxes and their rates.

Waste water charges have been introduced in all 10 Central and Eastern European Countries aiming to join the EU. The scheme of these taxes and charges does not show big differences compared to the schemes adopted in EU Member States.

Table 4: Water Abstraction Taxes Implemented in CEEC

Country	Water abstraction tax/charge	Tax rates
Bulgaria	Not applicable	Not applicable
Czech Republic	-surface water -ground water	-rates are set by river basin management company -0.05 EUR/m^3
Estonia	All sources	-between 0.0019 EUR/m^3 and 0.96 EUR/m^3 depending on water source and use of water
Hungary	All sources	between 0.006 EUR/m^3 and 0.04 EUR/m^3 depending on use of water
Latvia	-surface water -ground water	-0.003 EUR/m^3 -0.016 EUR/m^3 rate for mineral water is between 0.08 EUR/m^3 and 0.161 EUR/m^3
Lithuania	-surface water -ground water	-rate depends on the use of water

[11] OECD (Organisation for Economic Co-operation and Development) 1999a, The Price of Water Trends in OECD Countries, Paris.

[12] *Environmental Taxes and Charges. Proceedings of an International Fiscal Association seminar.* The Hague: Kluwer Law International, 1995, p. 160-161

		-0.009 EUR/m^3 (households); 0.02 EUR/m^3 (industry) and 1.22 EUR/m^3 (mineral water)
Poland	-surface water -ground water	-0.027 EUR/m^3 -0.08 EUR/m^3
Romania	-surface water -ground water	-0.005 EUR/m^3 – 0.0006 EUR/m^3 -0.006 EUR/m^3
Slovakia	-surface water -ground water	-0.5 EUR/m^3 -0.02 EUR/m^3 for public water supply and 0.5 EUR/m^3 for other uses
Slovenia	Not applicable	Not applicable

Source: REC 2000

1.4 Waste related taxes and charges

1.4.1 User charges for waste collection and disposal

An analysis of user charges for waste collection and disposal is very difficult to carry out for the same reasons as for user charges for water. The base for user charges in the waste sector can be quite heterogeneous. The tax base for households was the surface occupied in Italy until 1998. In 1999 a new regime of user charges was introduced and the user charges consists of two components; a fixed part depending on the waste disposal costs and a variable cost component which is proportional to the amount of waste produced by the household. A further obstacle to find comparable data for user charges is caused by differences in the national waste policies implemented in the countries analysed. Some countries, such as Switzerland, have adopted policies of variable rate charging schemes, i.e.: user-pay for municipal solid waste management, while in the UK such schemes are not permitted by the Environment Act.

1.4.2 Waste taxes

Most of the EU countries introduced waste tax (see Table 1). Sweden followed other EU Member States by introducing this tax in January 2000. The non-EU Member States covered in this report have either introduced it quite recently: Norway in 1999 and Switzerland in 2001. The comparison of waste tax rates between different European countries shows big differences in the tax rates but also in the actual structure. Different types of wastes can be subject to varied tax rates (Austria and Switzerland) and the rates can also depend on the type of waste disposal. For example, wastes delivered to an incinerator are exempt from the tax in the Netherlands, while in Flanders (Belgium), Denmark and Norway the tax rates for waste delivered to an incinerator depend on energy recovery. The overview in Table 6 shows the big differences in the waste taxes adopted in these selected countries and it also demonstrates some differences in waste management policies, such as the difference in the treatment of incineration. The waste management policy implemented in Flanders follows the EU waste management hierarchy, which assesses landfilling as the least desired option and prefers waste recycling compared to incineration which is seen as the second least desired option, by considering the incentive effect of a tax: the recyclable stream of waste is subject to a tax rate of zero, incineration of waste is subject to a tax rate of 6.2 EUR per tonne (with energy

recovery) and the least desired option of landfilling faces the highest tax rate. The same approach is adopted in Denmark but with higher tax rates.

In CEEC the use of this kind of economic instruments looks different. Latvia has implemented in recent years a whole range of waste-related taxes and charges, such as on batteries, disposable containers and tyres. However, this is an exceptional case compared to other CEEC; i.e. Hungary and Estonia are the only other countries in the region to have introduced any of these economic instruments[13].

Table 5: Waste taxes in selected European Countries (in EUR per tonne of waste).

	A	B	DM	FN	NL	NO	SW	SL	UK
Tax rate	5.8 – 29.1			15	13.6 – 29.7		28.4	9.3 – 31	3.2- 17.6
	Tax rates depending on type of disposal activities								
Landfill		61	49.8			37.5			
Incineration (with energy recovery)		6.2	37.2		0	basic tax: 9.4 additional tax up to 28[x]			
Incineration (without energy recovery)		10.2	43.9		0				

Sources: OECD (Organisation for Economic Cooperation and Development)

x - additional tax rate depends on degree of energy utilisation
A – Austria, B – Belgium, DM – Denmark, FN – Finland, NL – the Netherlands, NO – Norway, SW – Sweden, SL – Switzerland, UK – the United Kingdom

1.5 Eco taxes

During the period 1997-2000 there have been some minor developments in respect of the introduction of new taxes on agricultural inputs, such as taxes on fertilisers and pesticides. The intensification of agricultural practices - in particular, the growing use of fertilizers and pesticides - has had an increasing impact on water quality in Europe. In individual Member Countries, policies for controlling agricultural water pollution have gradually been extended to incorporate a mix of voluntary, regulatory, and incentive-based measures. However, there has been a great reluctance to use measures other than voluntary ones.

The developments in the introduction of eco taxes have mainly taken place in the Northern European Member States. Taxes in the agricultural sector are still not very common in the EU and are restricted to Scandinavian countries plus the Netherlands and Belgium. Again a forerunner in terms of new taxes is Denmark that introduced a tax on growth promoters in 1998. Denmark increased the tax rates levied on

[13] OECD (Organisation for Economic Co-operation and Development) 2000, *Sourcebook on Environmental Funds in Economies in Transition*, Paris 2000.

agricultural inputs over the period 1997-2000. The sale of pesticides and fertilisers is subject to a reduced VAT rate in several countries, which is environmentally counter-productive. According to a report by the European Fertilisers Manufacturers' Association, the reduction in fertiliser use has been significant in the Netherlands and in Denmark. Both countries have large intensive rearing sectors and have implemented economic instruments in the agricultural sector. The tax on fertilisers has been abolished in Norway, i.e. the tax rates are set to zero. Additionally, the structure of the pesticides tax has also changed in Norway. The changes introduced in 1999 are based on the estimation of a standard dose (per unit of area per year) for each pesticide separately. The pesticides are put into different bands according to the health and environmental risk and the tax levied on them is differentiated between the risk classes.

In Spain it is proposed to introduce an eco-tax on tourism in the Balearic Islands. The objective of this economic instrument is to alleviate the environmental consequences of mass tourism, and the tax is to be levied on all visitors regardless of whether they stay in hotels, apartments or campsites on the islands[14].

[14] Louise Prior: *Balearics defends eco-tax*; TTG (Travel Trade Gazette), U.K. and Ireland, Tonbridge; February 11, 2002; pg. 5

2. Revenues from environmental taxes

The environmental taxes and charges analysed in this report are of minor importance in terms of revenue generating, i.e. on the macroeconomic level. However, as explained above, the main purpose of these economic instruments is not to raise revenue but to have an incentive effect in reducing environmental pollution. The revenues raised by the taxes and charges are not significant on a macroeconomic scale, representing only a small fraction of tax receipts. However, the revenues do represent significant amounts of money at the sector or company level.

2.1 Options for the use of environmental taxes

Revenue from environmentally related taxes can be paid into general government budget (see Table 9), and its use determined by wider policy issues. The revenues could contribute to a budget surplus or alleviate a budget deficit, provide room for discretionary increases in government expenditures, or discretionary reductions in other taxes[15]. A policy of reducing public debt, which reduced interest rates and shifted money to the private sector, would have the least negative impact on the economy.

Alternatively, the revenue might be earmarked to specific spending purposes, some of which may be environmentally motivated. They can also be allocated to targeted reductions in other taxes. There are many examples of earmarked revenues in waste management and water management, although in these examples, charges rather than taxes raise most revenue. Taxes can also be earmarked, for example fuel taxes are often earmarked for road building.

According to some authors[16], there are disadvantages to earmarking revenues. First, earmarking fixes the use of tax revenue in advance, which creates obstacles for a re-evaluation based on economic and environmental rationale of a targeted expenditure programme financed by earmarked revenues, and the frequent result is inefficient spending of government revenue. For instance, allocating transport taxes to road infrastructure may lead to over-investment in that sector. Second, earmarking creates inflexibility; programmes may last longer than is optimal as of bureaucratic and other vested interests' obstruct reform, even when policy priorities have changed.

Revenue raised by environmentally related taxation can be used to reduce marginal tax rates and distortions in other markets. A number of governments have implemented environmentally related taxation, particularly those taxes that impact on industry, in a revenue-neutral manner, i.e. revenues raised are fully recycled back to the industry by some mechanism. For example, the Swedish NO_X charge is channelled back to the industry in proportion to the polluters' energy production.

Examples on the use of revenues include:

- Manure and Fertiliser: the use of revenue is treated differently across countries. In the Netherlands, the revenues go to the state budget (see Table 9). In Finland the revenues are used to support exports (subsidies),

[15] OECD: *Environmentally Related Taxes in OECD Countries*, France 2001

[16] i.e. B. Bosquet: "Environmental tax reform: does it work? A survey of empirical evidence." Paris 2000

and in Sweden, the environmental charge supported research and environmental related projects, but since 1994 the revenue has gone to the state budget but earmarked for environmental improvements in agriculture.

- Landfill tax: These are recycled - in France mainly to municipalities via funds/investments and to a lesser extent: private (waste) sector & research activities; in Austria for the clean up of contaminated sites and recycling to landfill sites for environmental investments; in the UK, partially to fund environmental projects (though mostly offset national insurance contributions).
- Revenues from the tax on Disposable Containers go to the National Exchequers in Finland, Denmark and Sweden.

Table 6. Use of revenue from the product/pollution taxes and charges

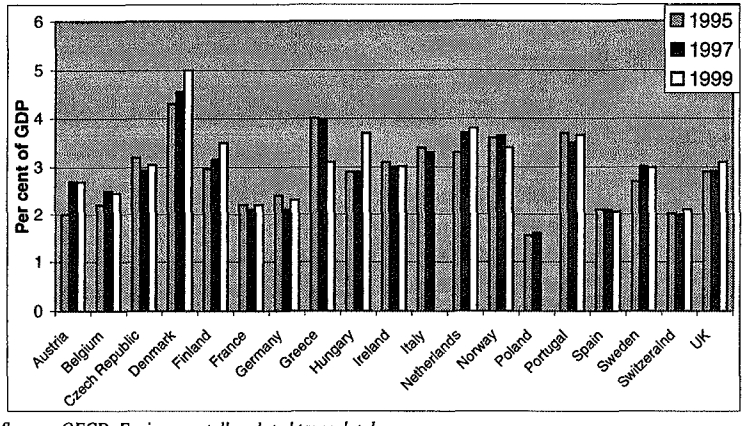
Taxes/ charges	Country	Revenue use	Country	Revenue use	Country	Revenue use
1) NO_X taxes and charges	S	Refunded to firms on basis of production of useful energy	E	Fund for environmental restoration (5% of revenues) – remainder to general budget	F	Abatement (66%) and monitoring (17%) equipment and R&D (10%)
2) Water abstraction charges	NL	General budget	DK	General budget	E	Recovery of costs of water infrastructure
3) Waste Water Charges	DK	General budget, though a substantial sum was devoted to an independent Water Fund, to finance projects which protect groundwater resources	NL	Hypothecated for identification and funding of investments in sewage treatment plants	D	Recycled for investments in sewage treatment plants
4) Pesticides Taxes and Charges	S	General budget	DK	Initially 55% of revenues were used to reduce county land tax, and around 10% was channelled back to farmers via support to organic farming. The remaining 35% of the revenue was used on research and on monitoring of pesticides in the environment	B	Eco-tax: state budget New pesticides charge: Used to fund registrations etc.
5) Mineral Surpluses and Fertiliser	NL	General budget	FIN	Export subsidies	S	Environmental charge: research and environmentally related projects. Since 1994: state budget, but earmarked for environmental improvements in agriculture.
6) Landfill taxes	F	Recycled to municipalities via funds/ investments and to a lesser extent, private (waste) sector & research activities	UK	Tax credits used to support environmental projects	A	Clean-up of contaminated sites and recycling to landfill sites for environmental investments
7) Aggregates Tax	DK	General budget	S	General budget	UK	New sustainability fund
8) Packaging Taxes	FIN	National Exchequer	DK	National Exchequer	S	National Exchequer
9) Batteries Taxes	I	Revenue used to finance collection of batteries	B	No information given	HU	Environmental protection.

Source: ECOTEC 2000

2.2 Total revenues from environmentally related taxes in European countries

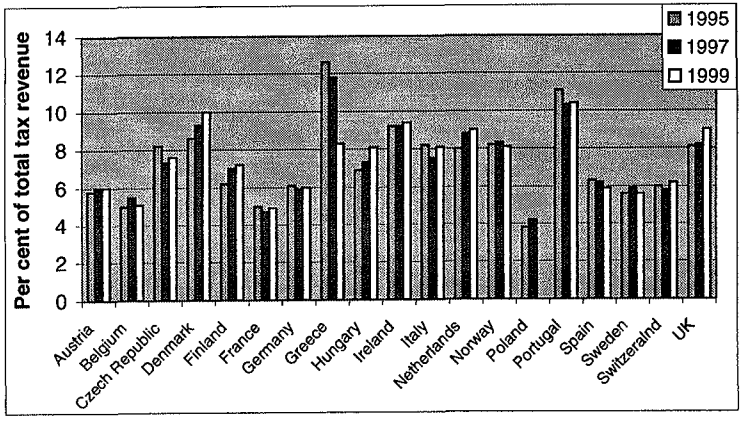
The three graphs below show total revenues from environmentally related taxes in per cent of GDP, total tax revenues and per capita in European countries.

Graph 1: Revenues from environmentally related taxes in per cent of GDP



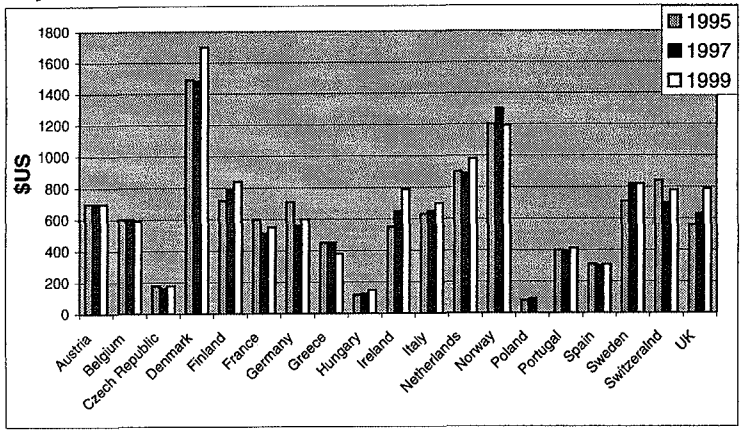
Source: OECD, Environmentally related taxes database

Graph 2 Revenues from environmentally related taxes in per cent of total tax revenue



Sources: OECD, Environmentally Related Taxes database

Graph 3 Revenues from environmentally related taxes per capita



Sources: OECD, Environmentally Related Taxes database

The revenues from environmentally related taxes amount to, on average, in the order of 2% of GDP and 5% of total tax revenues. Measured per capita the revenues from these taxes vary between less than $100 to almost $1 700 per year, with an average of about $500 per year (Graph 3).

Denmark is the country where the revenues from the taxes in question constitute the largest share of GDP, while Greece or Portugal are the countries with the largest share in total tax revenues. Denmark and Norway are the countries with largest revenues per capita.

2.3 Revenues from different individual tax bases

In EU Member States as a whole the share of energy and environment taxes in total taxation declined slightly between 1970 and 1999, from 7.2% to 6.9%, although their share in GDP increased from 2.4% to 2.9%. From 1990 to 1999 the share of energy and environment taxes in both GDP and total taxation showed an increase. Unleaded petrol is clearly the tax base on which the largest amount of revenue is raised. In 1998, almost 40% of all the revenue from the taxes included in this project was raised on unleaded petrol. Taxes on leaded petrol raised about 4% of the revenue. The fact that 10 times more revenue was raised on unleaded than on leaded petrol does not indicate that the tax rate per litre was higher for unleaded fuels. Instead, as a result of a combination of economic and regulatory measures, leaded petrol has more or less disappeared from the market in many countries. In terms of revenues raised, the second most important tax-base is the use of motor vehicles, represented for example by annual taxes on the use of passenger cars. This tax base represents more than 20% of the total environmentally related tax revenues[17].

Altogether, taxes on petrol and diesel (the tax base generating the third largest revenue), and on the sale or use of motor vehicles, generated more than 90% of all the pollution control related tax revenue in the European countries. In other words, only a very small part of the revenue was raised on other tax bases, such as fossil fuels used for heating purposes and, especially, fossil fuels used in industrial processes.
Table 10 presents the summary of revenues from environmentally related taxes and charges.

Table 7. Revenues from environmental taxes and charges

1) Nitrogen Oxides (NOx) Taxes and Charges	S	SEK ~600 million (MEUR ~70) but all revenue is refunded	E	ESP ~2333 million (MEUR ~14)	F	FF ~30 million (1991) -70 million (1998) (MEUR ~4.6- 10.8).
2) Water Abstraction Charges	NL	360 million NLG (MEUR163.4) (expected in 2000)	DK	1600 million DKK (MEUR 214) (1998-99)	E	1997 6,290m Pesetas (MEUR 37.8)
3) Waste Water Charges	DK	310 million DKK (MEUR 41.6) (1998)	NL	1940 million NLG (MEUR 880) (1996)	D	720 million DM (MEUR 368.1) (1998)
4)Pesticides Taxes/ Charges	S	38 million SEK (MEUR 4.2) in 1998	DK	302 million DKK (MEUR 40.5) in 1998	B	No information

[17] *"Study on the Economic and Environmental Implications of the Use of Environmental Taxes and Charges in the European Union and its Member States"*, ECOTEC in association with University of Gothenburg, April 2001.

5) Mineral Surpluses and Fertiliser	NL	Estimate: NLG 16 million per year (MEUR 7.3)	FIN	No data	S	1985: SEK 93 million (MEUR 11) environmental charge 1988: SEK 141 million (MEUR 16) (price regulation charge not included)
	A	1993/ '94: MATS 1177 (MEUR 85)				
6) Landfill taxes	F	1997: 906 MFF (MEUR: 138) (% GDP: 0,01) 1998: 1837 MFF (MEUR: 280) (%GDP:0,02	UK	1998-1999 £335m MEUR 536	A	1997 447.7 m ATS (MEUR 605)
7) Aggregates tax	DK	1995: 135.718.000 DKK (MEUR 18.2)	S	144.4 m SEK (MEUR 16.0) (1999)	UK	Estimated £380 million (MEUR 605)
8) Packaging Taxes	FIN	69m FIM (MEUR 11.6) 1998	DK	753m DKK (MEUR 101) in 1999	S	MEUR 13.1 (1992/93)
9) Batteries Taxes	I	NCU 24 BILLION LIRA (MEUR 12.4) in 1994	B	1996 PROFIT 64.4 MBEF (MEUR 1.6)	HU	767.9 MHUF (MEUR 2.90) in 1999

Source: ECOTEC 2000

Again, the amount of revenues raised is not the only relevant statistic regarding environmentally related taxes. From an environmental point of view, the relevant data is the resulting changes in behaviour that lead to substitution away from environmentally harmful goods or activities, with the potential for subsequently reduced tax revenue (but improved environmental effects).

3. Environmental Tax Reform (ETR) and its impact on labour policy

3.1 Environmental Tax Reform in European countries

As mentioned above, the revenues from taxes on pollution or natural resource depletion can be used to lower taxes on valuable economic activities, such as employment or investment. In that case we refer to this as "environmental tax reform" (ETR). ETR can provide two benefits: the *environmental* benefit from charging the full cost of environmental resources, and the *economic* benefit from the reduction in other taxes. ETR is thus said to offer the possibility of a "double dividend": it would help not only the environment but also the economy. By lowering other taxes in an appropriate manner, ETR can reduce some of distortions caused by the existing tax system and consequently encourage employment, investment, or both. If the benefits of the tax cut are greater than the economic burden of the environmental taxes, this can result in a "double dividend," increasing employment or GDP, as well as producing environmental benefits. Even if the benefits from tax cuts are less than the economic costs of the ecotax, they will still generally offset most of the economic cost, thus allowing a nation to minimize the economic cost of reaching its environmental goals[18].

In Europe eight nations have adopted such reforms (Denmark, Finland, Germany, Italy, the Netherlands, Norway, Sweden, and the United Kingdom) and other nations have announced that they will adopt them or have adopted elements of such reforms (Austria and Belgium). The Nordic countries were the pioneers, starting in the early 1990s by shifting taxes from labour (personal income, social security contributions, etc.) to the use of the environment (energy taxes, CO_2 taxes but also taxes on water and waste, etc.), but larger economies in western and southern Europe have since followed suit (see Table 8).

Most governments that have implemented ETR have reduced the tax wedge on labour in order to reduce unemployment. The weight of evidence from Belgium, Denmark, Finland, Germany, the Netherlands, the United Kingdom, as well as Europe as a whole, suggests that the best results in terms of employment are obtained when recycling occurs through cuts in social security contributions. This is because employers' social security contributions directly influence the price of labour. In the European Union as a whole, over 50% of total taxation falls on labour[19]. A number of voices have called for reducing the tax burden on labour in order to stimulate employment and economic activity. The European Commission itself recommended in the early 1990s that member states reduce the non-wage costs of low-income labour by an amount equivalent to 1-2% of GDP (1.5 to 4% of total tax revenue) by shifting taxes onto pollution and natural resources.

[18] J.A. Hoerner, B. Bosquet: " Environmental Tax Reform: The European Experience", Center for a Sustainable Economy, *Washington, DC February 2001*

[19] European Commission, *Environment and Employment: Building a Sustainable Europe* (Brussels: European Commission, Directorate-General XI, February 1998): 20

Table 8. Tax shifts in European countries

COUNTRY	TAX SHIFT		REVENUE SHIFTED
	FROM	TO	% OF TOTAL TAX REVENUE OR TAX REVENUE
Sweden 1990	Personal Income (reduction of labour taxes of around 4.3 percentage units)	Environmental and energy taxes including CO_2 tax and SO_2 tax	1.9 (revenue from environmental and energy taxes 18 bil SKR; 2 bil EUR)
Belgium 1993	Social Security Fund[1]	Energy tax	n.a.
Denmark 1993, 1995 and 1998[2]	Personal Income, Employers' Social Security Contributions, Investment Incentives	Various (electricity, water, waste, cars), CO_2 and SO_2	2.5 (2.4 bil DKR; 340 mil EUR in 2000)
Netherlands 1996	Personal Income, Corporate Profits, Employers' Social Security Contributions	Energy and CO2 (Regulatory Tax on Energy)	0.8 (2.2 bil HFL; 1 bil EUR in 1998)
Finland 1997	Personal Income, Employers' Employers' Social Security Contributions	CO_2 and Landfill	0.5
Italy 1999	Reduction of Employment Charges	CO_2	0.2 (around 600 mil EUR)
Germany 1999 and 2000	Employers' Social Security Contributions paid by employers and employees	Energy (mineral oils, natural gas and electricity)	n.a. a reduction by 0.8 percentage point[3] (8.4 bil DM; 4.3 bil Eur in 1999) a further reduction of 0.2 percentage point is estimated for 2000
France 1999	Reduction of the tax wedge on labour	TGAP (General Tax on Polluting Activities)	n.a.
Switzerland 1999/2000	Reduction of contributions to the medical health insurance	Tax on VOC and tax on light fuel oil (Sulphur tax)	n.a. 100 mil SF; 62 mil EUR in 1999/2000 increasing to 230 mil SF
United Kingdom 2001	Employers' Social Security Contributions (NIC) – a 0.3 % reduction in employers' social security contributions	Climate Change Levy (levied on business use of energy)–introduced in April 2001	n.a. 1 bil UKL; 1.6 bil EUR (est. for 2001/2002)
United Kingdom 2002	Reduction in Employers' Social Security Contributions	Aggregate tax – to be introduced in May 2002	n.a. 380 mil UKL; 609 mil EUR in 2002 (est.)

Sources: Recent Trends in the Application of Economic Instruments in EU Member States plus Norway and Switzerland, S. Speck, P. Ekins, Forum for the Future, London, July 2000

[1] A 1.5% reduction in employers' social security contributions was the result of this programme
[2] The reform in 1993 primarily concerned households, the reform in 1995 concerned industries and the latest reform in 1998 concerned both households and industries
[3] The 0.8 percentage reduction refers to social security contributions, which will be reduced from 20.3% to 19.5%.

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FUEL PRICE AND FUEL CONSUMPTION IN NEW ZEALAND: WOULD A FUEL TAX REDUCE CONSUMPTION?

Sandra A. Barns

ABSTRACT

This study estimates the relationship between fuel consumption and fuel price in New Zealand through the study of eleven years of quarterly fuel delivery and fuel price data, to investigate the potential effectiveness of a Pigouvian tax in reducing carbon dioxide emissions. For petrol, the short-run price elasticity was found to 0.195, however, in the long run consumers do not sustain initial fuel savings, and the estimated long run price elasticity of demand is 0.065. This result is similar to findings in US studies by Puller and Greening (1999) and Khazoom (1991), where the short run price elasticity was greater than the long run price elasticity. For New Zealand, the magnitude of the long-run price elasticity is lower than expected, and lower than overseas studies have found. While New Zealand evidence supports the existence of a significant negative relationship between petrol consumption and petrol price, the long run price elasticity of demand shows that the consumption response to price changes was small. Price elasticity of demand for diesel was unable to be estimated. A fuel tax within the range considered in this study is unlikely to be effective as a single tool to reduce carbon dioxide emissions in New Zealand.

INTRODUCTION

Fuel consumption is interesting to study because of both pollution and congestion. While congestion is important economically because of lost productivity through time in transit,[1] the relationship between fuel price and congestion does not appear to be exploitable: 'fuel charges cannot distinguish between time of day, location of road, and traffic density' (Australian Automobile Association, 2001, p.30). There is therefore limited application for studying fuel price in relation to congestion. The focus of this study is pollution because of the need to deal with climate change at a national level, and the perceived ability to adjust fuel price to achieve lower usage, and therefore lower pollution. This study examines the relationship between the price of fuel and the quantity consumed in the context of road transport, and investigates whether imposing a tax on fuel would achieve a reduction in fuel consumption, and a consequent reduction in carbon dioxide (CO_2) emissions.

New Zealand is a party to the 1994 United Nations Framework Convention on Climate Change and at this time is considering its commitments to the Kyoto Protocol, which would see New Zealand taking steps to achieve 1990 levels of greenhouse emissions for the first commitment period of 2008 to 2012 (Ministry of Economic Development, 2001a). The recent review of New Zealand's taxation system has considered the implementation of a carbon tax to meet New Zealand's Kyoto Protocol obligations. The review believes –

> *...a broad based carbon tax, aligned to international carbon prices and including the agricultural sector, merits consideration as New Zealand's central Kyoto measure for the first commitment period* (New Zealand Tax Review Authority, 2001, p.51).

Therefore, a study of the potential environmental consequences of a fuel tax is timely.

Economics posits that when externalities are internalised, an efficient level of usage results. In theory, efficient fuel taxes would reflect the marginal damage caused by CO_2 and other emissions, and would result in a reduction in emissions (Tietenberg, 1996). Environmental taxes can provide 'strong incentives' for efficiency throughout the economy, correcting the market price distortions arising when negative environmental externalities are not reflected in prices (Ministry for the Environment, 2001). Figure 1 shows the relationship between Q_m, the quantity of polluting activity when costs of pollution are not internalised by the polluter, and Q*, the quantity of polluting activity when the marginal cost of an activity includes the marginal social cost. When the price reflects the marginal social cost, the quantity of the damaging activity reduces to Q*.

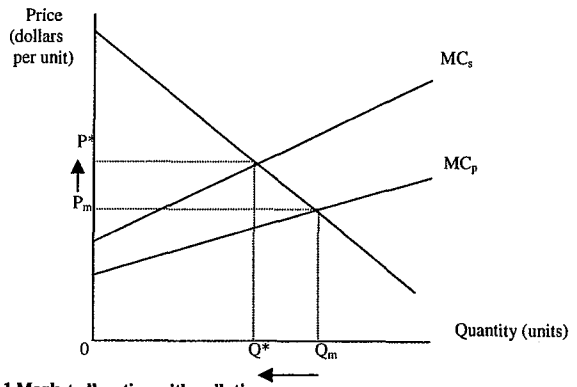

Figure 1 Market allocation with pollution
Source: Tietenberg (1996).)

[1] Congestion is believed to be costing the Auckland region $750m a year (Auckland Regional Council, 2001).

If this theory holds for transport use, consumers will respond to increases in fuel price by reducing usage. This study investigates whether this would be the case for New Zealand, using regression analysis to estimate the price elasticity of demand for road transport fuel in New Zealand. 'If a way could be found for the price of petrol to fully reflect the costs it imposes on the community from its use, consumers may choose other goods and services over petrol (for example, public transport)' (Commonwealth of Australia, 2001, p.9).

Achieving sustainable outcomes implies that the ability of future generations to meet for their own needs is not compromised by the actions of the current generation to meet their needs (Tietenberg, 1996). If fuel taxes resulted in reduced fuel consumption, sustainable outcomes in this context might be achieved. If fuel taxes do not reduce consumption, how will future generations be compensated for the compromised environment they inherit? If collected environmental taxes are spent on current fiscal commitments, future generations will almost undoubtedly be worse off than current generations.[2]

From an environmental perspective, fuel taxation would need to reflect the marginal damage of each fuel in the range of fuels available so as not to distort the price of one fuel relative to another. When taxation fails to reflect marginal damage of individual fuels there is a risk of encouraging the use of less desirable fuels (New Zealand Taxation Review Authority, 2001). Some European studies have concluded that different tax treatments of petrol and diesel vehicles have resulted in the relatively high growth in diesel vehicle numbers in Europe, even in the face of higher environmental costs of diesel-powered vehicles (Mayeres and Proost, 2001). Diesel-powered vehicles are a significant part of the New Zealand fleet, making up between nine and 10 percent of imported cars in the three years to 2000 (appendix 1). At this time when New Zealand diesel standards are lagging behind most developed countries in terms of fine particles emissions (Kedgley, 2001), this growth indicates that the current pricing mechanism is not signalling the greater environmental cost of diesel emissions. 'In New Zealand diesel fuel is taxed at a lower rate than petrol although it is more polluting than petrol' (Ministry for the Environment, 2001, p.14).

[2] Current taxes on New Zealand petrol are not an environmentally based, and the majority of the tax currently collected enters the Crown Account to meet current commitments (Treasury New Zealand, 1997).

Trends in transport growth in New Zealand are also of concern – from 1990 to 1998 growth in transport exceeded economic growth with total GDP increasing by 21%, while freight carried increased by 30%, and passenger transport increased by 36% (Ministry of Economic Development, 2001a). In most developed countries during this time, transport growth has been close to parallel to economic growth, while in most developing countries, road transport activity has outstripped economic growth (Chia, 1998).

New Zealand's emissions profile reflects the agricultural nature of the economy, with methane being the dominant greenhouse gas emitted. Carbon dioxide is second to methane, in terms of greenhouse emissions, making up 39 percent of New Zealand's greenhouse emissions (figure 2). Of that 39 percent, 43 per cent is attributable to domestic transport (figure 3). New Zealand has the highest proportion of carbon dioxide emissions from transport in the OECD, with the average proportion of carbon dioxide emissions at 30 percent (Ministry of Economic Development, 2001a).

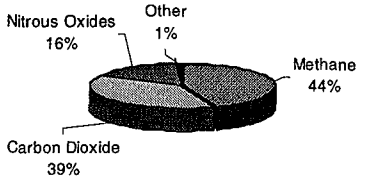

Figure 2 New Zealand greenhouse gas emissions profile.
Source: Ministry of Economic Development (2001b).

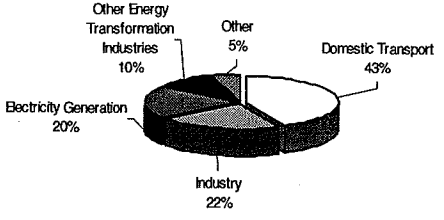

Figure 3 Carbon dioxide emissions from energy sector.
Source: Ministry of Economic Development (2001b).

TYPES OF POLLUTANTS

Pollutants fall into two categories – stock pollutants and fund pollutants. Stock pollutants are not absorbed into the environment, while fund pollutants are absorbed, and provided the emissions rate does not exceed the absorptive capacity of the environment, fund pollutants do not accumulate (figure 4). Carbon dioxide emissions are a fund pollutant, and plant life and the oceans absorb them (Tietenberg, 1996). Increasing CO_2 emissions suggest that it is likely that the absorptive capacity of the environment is being exceeded, and while there is conflict about the link between greenhouse emissions and global warming, certainly there is a strong relationship between emissions and air quality.

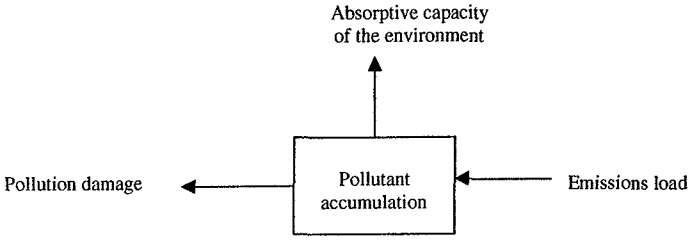

Figure 4: Relationship between emissions and pollution damage.
Source: Tietenberg (1996).

An excess of fund pollutants suggests that principles of sustainable development are being breached – that future generations will live in a compromised climatic environment. With this in mind, policy design should create incentives for changes in consumer behaviour and/or changes in technology.

How much pollution is efficient? Achieving an efficient level of pollution involves the minimization of the sum of the damage costs and control (or avoidance) costs. The shape of the curves in figure 5 illustrate that with low levels of pollution the marginal damage is minimal, but as pollution levels rise the damage cost is increasingly greater per unit of pollution. Similarly, with control costs, the marginal costs of achieving control of pollution at higher levels increases exponentially. The efficient allocation of a fund pollutant is represented by Q* in figure 5, the point where marginal damage of a unit of pollution is equal the to the marginal cost of control.

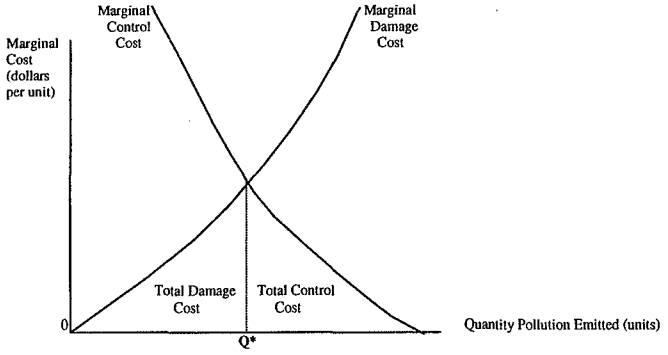

Figure 5: Efficient allocation of a fund pollutant.
Source: Tietenberg (1996).

A tax levied on transport fuel to produce an efficient level of use is a Pigouvian tax. The goal of reduced pollution at the least cost is achieved when a tax set at the level where the marginal cost of reducing the pollution is equal to the marginal environmental benefit (Ministry for the Environment, 2001). Three necessary conditions must be satisfied if a Pigouvian tax is to reduce emissions to a socially optimum level: the distribution of the impact of emissions must be uniform; emissions must be measurable; marginal damage must be measurable (New Zealand Tax Review Authority, 2001). If these conditions were met, a Pigouvian tax should reduce consumption as consumers adjust to the socially optimum level. A carbon tax on transport fuel is considered efficient because climate change is independent of the time or place of the emissions, and they are easily monitored (by proxy) (Barker and Johnstone, 1998; Vehmas et al, 1999; Ministry for the Environment, 2001). Measurement of marginal net damage is necessary for determining the appropriate tax rate, and while reliable estimates are difficult to obtain in the absence of observable market valuations, techniques do exist for measurement (New Zealand Tax Review Authority, 2001).

The price elasticity of demand for petrol is largely dependent on the availability of substitutes. Short run substitutes include the curtailment of travel, public transport and carpooling, improved vehicle maintenance, and reduced driving intensity. Where households have more than one vehicle, increasing the relative use of newer vehicles (which tend to be

more fuel efficient and less polluting) is also a short run substitute. Long run substitutes include the purchase of newer vehicles, and changes in proximity of residence and workplace (Khazzoom, 1991). Microeconomic theory posits that long run price elasticity of demand should be greater than short run because the available substitutes in the long run include all short run options, plus those that are only available in the long run. However, differences in the nature of short- and long run substitutes may preclude this – fuel substitutes in the short run necessitate behavioural change, while long run substitutes tend to be tangible changes. Behavioural changes may be difficult to sustain over the medium to long term.

EMPIRICAL ANALYSIS

Regression analysis was performed using eleven years of quarterly data. A negative relationship between petrol price and petrol deliveries (volume) is expected. Demand is expected to be relatively inelastic, particularly in the short run, as petrol is a necessity in modern living and short-term substitutes such as public transport and reducing driving intensity do not offer a substantial ability to reduce consumption. Expectations regarding price elasticity for diesel are less clear because the majority of diesel consumed in New Zealand is for business, which has a lesser ability to reduce consumption in the face of price increases.

The data for estimating the relationship between petrol deliveries, GDP and the petrol price index comprises 50 quarterly observations from the first quarter 1989 to the second quarter 2001. The data series used were petrol deliveries[3] (NRGQ.SPD5A), GDP (SNCQ.S1RB15), and a household petrol price index[4] (NRGQ.S1HZ5), each obtained from Statistics New Zealand. The data for estimating the relationship between diesel deliveries, GDP, and diesel price comprised 43 observations from the fourth quarter 1990 to the second quarter 2001. The series used were diesel deliveries[5] (NRGQ.SPD5B), GDP (SNCQ.S1RB15), and a commercial diesel (bulk) price index (NRGQ.SICZ7), obtained from

[3] These figures represent the total of deliveries of petrol from all the oil companies to resellers plus direct to industry within New Zealand.

[4] The CPI Petrol Price Index measures price change of 91 octane petrol, 96 octane petrol and petrol additive. Petrol additive is priced only quarterly, as it is not subject to frequent price change. Within each CPI region, an average price per 10 litres of each of the two types of petrol is calculated from the prices surveyed from individual service stations, for each of the two periods within each month. Monthly regional average prices for each of the two types of petrol are then calculated as the simple averages of the averages for the two periods within each month. Quarterly regional average prices for each of the two types of petrol are then calculated as the day-weighted averages of the averages for the three months within the quarter. Regional price movements from the base (i.e. June 1999) quarter to the current quarter are then weighted by the regional population weights to calculate the national Petrol Price Index for the current quarter (Statistics New Zealand, 2001).

Statistics New Zealand. In the absence of an individual household diesel price index, it was assumed that diesel pump prices follow a similar pattern to the commercial index.[6] Delivery data were not available in a seasonally adjusted form and the GDP series was unadjusted. The period of the study included a period in mid-2001 when the price of petrol rose to unprecedented levels in New Zealand[7] due to a weak exchange rate and restricted supply by OPEC. All fuel delivery data were in thousands of tonnes (000).

METHODOLOGY

Seasonal patterns are expected in both the GDP and deliveries series data. While seasonally adjusted data was available for GDP, deliveries data were only available in an unadjusted (raw) form. Working with the unadjusted form for both series, the effect of seasonality was captured using dummy variables in the regression equation. Initial testing was performed using the classical ordinary least squares model, where –

$$\text{Deliveries} = f(\text{GDP}, \text{Price})$$

The model was estimated in logged form for each of petrol and diesel deliveries. Initially a simple model was estimated. Insignificant seasonal variables were removed and experimentation and testing of various lagged values was performed to improve the model and to introduce a dynamic structure. Signs of coefficients were checked for conformation with expectations. In the logged model, coefficients describe the percentage change in the dependent variable (deliveries), for a one-percentage change in the independent variable (GDP, Price), giving the price elasticity of demand. This provides an insight into how the quantity demanded responds to a change in price. Goodness of fit was checked, and diagnostic tests for serial correlation, functional form, normality of the error term, and heteroscedasticity were carried out.

STATIONARITY AND COINTEGRATION

The individual data series were tested for stationarity using the augmented Dickey Fuller and Phillips-Perron tests. Non-stationary series were tested for cointegration using the

[5] The total of deliveries of diesel from all the oil companies to resellers and industry.

[6] Data detailing the amount of diesel sold at pump prices and amounts sold at commercial prices would have indicated the correctness of using this index but it was unavailable.

[7] Retail petrol prices rose 6.5 percent from the March 2001 to the June 2001 quarter. Prices in the June 2001 quarter were 9.6 percent higher than in the same quarter of the previous year. Retail prices for alternative motor

augmented Dickey Fuller and Phillips-Perron tests. Results from these tests were ambiguous, so for confirmation of cointegration, the first stage of the ARDL procedure (Pesaran and Shin, 1995; Pesaran et al., 1996) was applied. This procedure can be applied irrespective of whether regressors are I(0) or I(1), avoiding pre-test problems associated with standard cointegration analysis which require the classification of variables into I(0) or I(1). The ARDL procedure involves two stages. The first stage tests for the long-run relationship between variables by computing the F-statistic for testing the significance of lagged levels of the variables in the error correction form of the underlying ARDL model. If results are outside the band, the second stage estimates an ARDL regression equation (the second stage was not performed in this case).

While petrol (diesel) deliveries, GDP, and the petrol (diesel) price index may be cointegrated in the long run, in the short run there may be disequilibrium. The error correction model (ECM) gives short run values, and captures the adjustment toward the long run equilibrium (Gujarati, 2000; Koop, 2000). An ECM was indicated for the petrol price data, although not for diesel.

To obtain a formal statistical measurement of the time series stationarity, unit root tests on individual series were calculated using the augmented Dickey Fuller and Phillips-Perron tests (table 1).

Variable	Augmented Dickey Fuller (ADF)		Phillips-Perron (PP)		Explanation of results
	Constant, no trend	Constant, trend	Constant, no trend	Constant, trend	
Deliveries Petrol (logged)	-1.04	-1.10	-2.81	-6.12	Both tests show petrol deliveries to be nonstationary; PP finds it stationary with a trend.
Deliveries Diesel (logged)	-1.33	-1.27	-2.82	-5.48	Both tests show diesel deliveries to be nonstationary; PP finds it stationary with a trend.
GDP (Petrol) (logged)	-0.30	-2.41	-1.65	-7.88	Both tests show GDP to be non-stationary; PP finds it stationary with a trend.
GDP (Diesel) (logged)	-1.56	-2.29	-1.62	-8.20	Both tests show GDP to be non-stationary; PP finds it stationary with a trend.
Petrol Price (logged)	-1.23	-1.36	-1.43	-1.55	Both tests show petrol price to be nonstationary with and without a trend.
Diesel Price (logged)	-1.60	-2.48	-1.43	-1.55	Both tests show diesel price to be nonstationary with and without a trend.
Critical Test Statistic (5%)	**-2.86**	**-3.41**	**-2.86**	**-3.41**	

Table 1: Findings of augmented Dickey-Fuller and Phillips-Perron tests for stationarity.

The augmented Dickey Fuller test consistently shows the data to be non-stationary. The Phillips-Perron tests indicate non-stationarity, with the exception of GDP and diesel deliveries, which are stationary with a trend. Further testing shows all the data to be stationary first difference stationary. A deterministic trend in the data is assumed.

As all the data is I(1), the variables can be tested for cointegration. Testing was performed on the logged variables of both petrol and diesel data using both the augmented Dickey-Fuller and Phillips-Perron tests. Because there is seasonality in the data, the seasonal trends have been identified using dummy variables. In testing for cointegration using the delivery variable, deliveries were regressed on the dummy variable and the residuals saved for the cointegration test. If this is not done, cointegration results are likely to be incorrect. In the case of petrol deliveries, the dummy variable for the second quarter is significant at the 5% level. In diesel deliveries, both the second and fourth quarters are significant at the 5% level. Table 2 records results.

Variable	Augmented Dickey Fuller (ADF)		Phillips-Perron (PP)		Explanation of results
	Constant, no trend	Constant, trend	Constant, no trend	Constant, trend	
Petrol – logged (deliveries; GDP; price)	-1.01	-2.63	-8.99	-5.91	The PP test shows that the series cointegrate; the ADF suggests they do not.
Critical Test Statistic (5%)	**-3.74**	**-4.12**	**-3.74**	**-4.12**	
Diesel – logged (deliveries; GDP; price)	-1.14	-2.83	-13.69	-11.15	The PP test shows that the series cointegrate; the ADF suggests they do not.
Critical Test Statistic (5%)	**-4.10**	**-4.43**	**-4.10**	**-4.43**	

Table 2: Findings of augmented Dickey-Fuller and Phillips-Perron tests for cointegration.

fuels rose 3.0 percent from the March 2001 quarter to the June 2001 quarter, and were 9.1 percent higher than the level recorded in the June 2000 quarter (Statistics New Zealand, 2001).

The conflicting results from the augmented Dickey Fuller and Phillips Perron tests make it difficult to draw a definitive conclusion. Accordingly, stage one of the ARDL procedure was performed with a one-period lag (table 3).

	Petrol Data Testing	Diesel Data Testing
Dependent variable	LDEL	LDEL
Calculated F-stat	5.188	.3835
Critical F - 95%	3.79 – 4.85	3.79 – 4.85

Table 3: Results from stage 1 testing of ARDL procedure.

The above test results for petrol suggest that there exists a long-run relationship between LDEL, LGDP, and LPR, and that the variables LGDP and LPR can be treated as long-run forcing variables for the explanation of LDEL (Pesaran and Pesaran, 1999). With the testing of the diesel data, because the calculated statistic for LDEL falls below the inconclusive region, we accept the null hypothesis that there is no cointegrating relationship. Therefore, a long run model for diesel deliveries was not estimated.

INITIAL TESTING – CLASSICAL MODEL

The general model used in this study is:

$$DEL = \alpha + \beta D_2 + \beta D_3 + \beta D_4 + \beta GDP_t ... + \beta GDP_{t-k} + \beta PR_t ... \beta PR_{t-k} + \gamma Y_{t-1} ... + \gamma Y_{t-k} + \mu_t \quad (1)$$

where DEL is deliveries of fuel, α is a constant; D denotes dummy variables; GDP is Gross Domestic Product; PR is fuel price index; β is the coefficient for the independent variables; γ is the coefficient of lagged values of the dependent variable deliveries; and μ is the random error term.

In testing the logged model for the relationship between petrol deliveries and GDP and the petrol price index, a simple logged model with no lagged values was estimated. The resulting equation was –

LDEL (Petrol) = 1.690 -0.0294D2 + 0.004D3 + 0.0073D4 + 0.4979LGDP - 0.0631LPR
t-ratios (4.5464) (-3.6157) (0.48595) (0.84946) (16.6585) (-1.5722)
R^2 Adjusted 0.87664
DW Statistic 1.1340

DIAGNOSTIC TEST	p VALUE
Serial Correlation	0.053
Functional Form	0.410
Normality	0.981
Heteroscedasticity	0.023

Insignificant dummy variables were removed. The sign of LGDP is positive, while the sign of LPR was negative, a priori. The DW statistic indicates autocorrelation, although the p-value for the LM test for serial correlation statistic does not. The diagnostic test results each indicate accepting the null hypotheses,[8] with the exception of the ARCH test, which indicates heteroscedasticity in the model.

Experimentation with the addition of various lagged values of the independent and dependent variables was carried out and the Log of Likelihood function was used to determine which variables added value to the model. The following final model was estimated –

LDEL(Petrol) = 1.556 – .036D2 + .273$LDel_{t-1}$ + .483LGDP – .140$LGDP_{t-1}$ – .0649LPR
t-ratios (4.2632) (-6.0304) (2.3483) (11.559) (-2.2199) (-1.7783)
R^2 Adjusted 0.89980
DW Statistic 1.9298

DIAGNOSTIC TEST	p VALUE
Serial Correlation	0.582
Functional Form	0.356
Normality	0.735
Heteroscedasticity	0.098

In this autoregressive distributed lag model, all coefficients are significant at the 5% level, and signs are as expected. The adjusted R-square indicates that nearly 90 percent of the variation in the model is explained by the regression equation. The DW test statistic of 1.92 indicates no first order autocorrelation. Diagnostic tests all indicate acceptance of the null hypotheses at the 5% level of significance.

When a cointegrating relationship exists, the Granger Representation Theorem states that the relationship can be expressed as an error correction model (ECM). While the OLS approach gives the long run behaviour of the estimated model, the error correction

[8] Diagnostic Test Hypotheses:
Serial correlation (Lagrange Multiplier test) H_0: No serial correlation. H_A: Serial correlation is present.
Functional form (RESET test) H_0: Well-specified model. H_A: Model mis-specified.
Normality test (Jarque Bera test) H_0: Residuals normally distributed. H_A: Resid. Not normally distrib.
Heteroscedasticity test (ARCH test) H_0: No heteroscedasticity. H_A: Heteroscedasticity is present.

mechanism corrects for disequilibrium, in doing so the ECM estimates the short-run behaviour of variables (where simply regressing Y on X gives the long run behaviour).

To arrive at the ECM for the petrol equation, a long run model was estimated, where the independent variables of LGDP, the LPR and the dummy variable for the second quarter (previously found to be significant in petrol deliveries) are regressed on LDEL. The residuals were saved, and then tested for stationarity using the augmented Dickey Fuller test. Findings show the residuals to be I(0). The differenced series of deliveries, price and GDP are known to be I(0) from earlier testing.

The ECM model is as follows –

$$\Delta DEL_t = \alpha + \beta\Delta GDP_t + \beta\Delta PR_t + \beta EC_{t-1} \qquad (2)$$

where Δ indicates (t-(t-1)), α is a constant; β are coefficients, DEL, GDP, and PR are deliveries, GDP and price, and EC is the error correction term.

The initial error correction model for petrol deliveries was estimated –

LDEL(Pet) = .4561E-3 + .4188LGDP - .0169LPR – .5254EC $_{t-1}$
t-ratios (.10725) (6.8473) (-.15258) (-2.4734)
R^2 Adjusted 0.51711
DW Statistic 2.2957

DIAGNOSTIC TEST	p VALUE
Serial Correlation	0.000
Functional Form	0.001
Normality	0.789
Heteroscedasticity	0.311

The correction mechanism is significant in this model, but diagnostic tests indicate serial correlation and an incorrect functional form. Experimentation and testing with the addition of various lagged values of independent dependent variables yield the final model –

LDEL(Pet) = .0018 + .2290LDEL $_{t-3}$ + .6812LGDP - .2260LGDP$_{t-2}$. + .1677LGDP$_{t-3}$ - .1953LPR -.7711EC $_{t-1}$
t-ratios (0.481) (2.1276) (13.5112) (-3.7724) (-1.7399)
(-2.9079) (-5.3706)
R^2 Adjusted 0.84876
DW Statistic 2.0044

DIAGNOSTIC TEST	p VALUE
Serial Correlation	0.973
Functional Form	0.106
Normality	0.842
Heteroscedasticity	0.835

In this model, the constant is not significant. All other coefficients with the exception of the LPR are significant at the 5% level, while LPR is significant at the 10% level. The sign of LPR is negative, a priori. The significant coefficient for residuals (t-1) has the correct sign, and confirms disequilibrium in the model, while the coefficient is high, suggesting the discrepancy is corrected fairly quickly, that is 77.11% of the discrepancy between actual deliveries and the equilibrium is corrected the next period, and 94.8% of the discrepancy is corrected within 2 periods. The adjusted R-square indicates that 86% of the variation in the model is explained by the regression equation. Diagnostic tests for serial correlation, functional form, normality of the error terms, and heteroscedasticity indicate acceptance of the null hypotheses at the 5% level of significance.

Testing for cointegration of the diesel series indicated no cointegrating relationship and so an error correction model was not appropriate, therefore a difference equation was estimated. The initial model was estimated –

LDEL(Dsl) = .05272 -.0249D2 - .1083D3 + .0266D4 - .4350ΔLGDP + .0154ΔLPR
t-ratios (-.1.0989) (-.42021) (-3.6220) (.18475) (-.53629) (.080861)
R^2 Adjusted 0.19492
DW Statistic 1.7929

DIAGNOSTIC TEST	p VALUE
Serial Correlation	0.104
Functional Form	0.138
Normality	0.707
Heteroscedasticity	0.699

While this initial model passes all diagnostic tests, there is a problem with the sign of the coefficients for LGDP and LPR – there is a negative relationship between LDEL and LGDP, and a positive relationship between LDEL and LPR. . However, these coefficients are not significant. The goodness of fit statistic is 0.19492, indicating that the model does not explain the relationship well. Experimentation with various lags yields the final model –

$$L\Delta DEL(Dsl) = .0109 + .4392\Delta LGDP + .9206\Delta LGDP_{t-1} + .5236\Delta LGDP_{t-2} - .0997\Delta LPR + .1762\Delta LPR_{t-1}$$

t-ratios (1.0410) (2.2956) (3.7028) (2.8377) (-.50680) (-.97010)

R^2 Adjusted 0.29468

DW Statistic 1.8014

DIAGNOSTIC TEST	p VALUE
Serial Correlation	0.175
Functional Form	0.586
Normality	0.622
Heteroscedasticity	0.605

LΔGDP in the current period and for two lagged periods each have a positive impact on deliveries. The LΔPR has a negative relationship with LΔDEL, but is not significant, and LΔLPR lagged one period has a positive relationship, but again is not significant. The adjusted R-square indicates that 29 percent of the variation in the model is explained by the regression equation. Clearly other factors are significant in this short-run equation. Diagnostic tests for serial correlation, functional form, normality of the error terms, and heteroscedasticity all indicate acceptance of the null hypotheses at the 5% level of significance.

EVALUATION OF ELASTICITIES

	Short-Run	p-value	Long-Run	p-value
Petrol – Price Elasticity	-.195	.006	-.065	.082
Diesel – Price Elasticity	-.100	.616	-	-

Table 4: Price elasticity estimates.

The low price elasticity demand for petrol is expected because substitutes for petrol are relatively few. The price elasticity for petrol has a larger impact in the short-run at -0.195 (significant at 1 percent), compared with -0.065 (significant at 10 percent) in the long run. The magnitudes indicate that initially when prices rise, commuters take advantage of available substitutes (although substitutes are limited in the short run, reflected in the price elasticity of demand), but over a longer period, their behaviour tends to return to pre-price-change patterns. Many substitutes for petrol involve changes in behaviour, and while this may occur in the short-run, sustaining behavioural changes may be more difficult in the long run. In a 1999 United States microdata study, Puller and Greening found a stronger initial response to petrol price change, with consumers adjusting vehicle miles travelled and miles

per gallon, but in subsequent quarters vehicle miles travelled 'snapped back' to earlier levels, while miles per gallon gradually declined. Khazoom (1991) argues that initially a price rise reduces short-run demand, but in the long run consumers switch to vehicles that are more efficient which lowers the marginal cost of travel, and in so doing encourages a greater demand for travel. The magnitude of the short-run price elasticity found in this study is similar to that found in other research, while the magnitude of the long-run elasticity is lower than in all other studies reviewed. This suggests that New Zealanders' short run response to petrol price increases is similar to citizens of other countries, but the long run is lower. Is this a reasonable finding? Possibly. Growth in transport in New Zealand exceeded the growth in economic activity for the 1990 to 1998 period, which is unusual for a developed country, where typically transport growth and real GDP have been close to parallel (Chia, 1998). Further, studies of aggregate data include fuel purchased for commercial use, while microdata studies are able to differentiate between household and business consumption. Price elasticity estimates that include commercial consumption are likely to be lower than those that do not because of the lesser ability of business to respond to fuel price changes, at least in the short-run. In addition, short run responses to price increases are behavioural, and may not be sustainable in the long run. Findings by Kerr (2001) support some behavioural responses of New Zealanders that differ from similar overseas studies.[9] Table 5 shows summarised price elasticities from this and previous studies for comparison.

Study	Year	Country	Price elasticity Long-run	Short-run	Data type
Barns	2002	NZ	-0.065	-0.195	Aggregate
Puller & Greening	1999	US	-0.785*	-0.345*	Microdata
Hsing	1994	US	-0.130		Aggregate
Goel	1994	US	-0.168		Aggregate
Archibald & Gillingham	1981	US	-0.772		Microdata
Sargious et al	1981	Canada	-0.240		Microdata

* Mean of range given.

Table 5: Summary of results

CONCLUSIONS

A statistically significant negative relationship exists between petrol consumption and petrol price, with price elasticities of -0.195 in the short-run and -0.065 in the long run.

[9] Including 'relatively equal' consumption across ethnic groups, although Pakeha/European use is 'somewhat

The relationship between diesel price and diesel deliveries was unable to be estimated in the long run, and the short run price coefficient was not significant. Intuition suggests that diesel price may be an insignificant variable in diesel deliveries; much of the diesel used in New Zealand is for commercial use, which is less responsive than private use to price movements. The assumption that the commercial bulk diesel price index was a suitable proxy for diesel pump prices may have been incorrect.

The price elasticity of demand for petrol suggests that a tax within the range of the data represented in this study would do little to influence consumption. A tax that significantly increased the price of petrol may encourage technological advancement, as research and development of cleaner technology become viable. Similarly, a lesser tax earmarked for research and development of environmentally sustainable vehicles and fuels may achieve the same objective. It is unclear how a substantial tax (beyond the study data range) would affect consumption. However, if environmental taxes are applied, it is important that transport fuels are taxed individually to reflect the marginal environmental damage of each, and commuters internalise the externalities associated with the fuel they use. Not doing so is likely to result in an undesirable mix of vehicles on our roads.

Further research using microdata would be useful in determining precisely the reasons for the lesser long run than short run response, and the relatively low long run response to price change by New Zealanders. An improved knowledge of these characteristics may be helpful in identifying policy responses that could effectively reduce fuel consumption.

higher', and a positive relationship between educational achievement and petrol expenditure.

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Appendix 1 **Vehicles registered during the year, by vehicle type and fuel type.**

Vehicles Registered during the Year, by Vehicle Type and Fuel Type														
	Petrol		Diesel		CNG		LPG		Electric		Other		Total	
	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999
Cars	161,511	170,420	17,199	18,884	-	-	57	9	-	-	-	-	178,767	189,313
Trucks	4,963	4,782	18,884	16,710	-	-	7	1	-	-	-	1	23,854	21,494
Motorcycles	5,592	4,096	-	-	-	-	-	-	-	-	-	-	5,592	4,096
Tractors	196	71	2,423	1,221	2	1	2	9	-	-	10	7	2,630	1,309
Buses/Coaches	74	135	701	696	-	1	2	2	-	-	-	-	778	834
Mobile Machines	172	95	649	566	2	-	70	29	15	19	7	7	915	716
Motor Caravans	67	18	560	498	-	-	-	-	-	-	-	-	627	516
Mopeds	1,323	493	-	-	-	-	-	-	-	-	-	-	1,324	493
ATV	391	336	5	2	-	-	1	-	1	-	-	-	398	338
Special Purpose Vehicles	2	-	67	54	-	-	-	-	-	-	-	-	69	54
Agricultural Machines	18	6	97	58	-	-	-	-	-	-	-	-	115	64
Total	174,306	180,452	40,585	38,689	4	2	139	50	17	19	18	15	215,069	219,227

Source: Land Transport Safety Authority

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BEHAVIOUR CHANGE: THE IMPACT OF INSTANT FINES AT THE BORDER

by

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Summary

This paper describes key elements of the policy process used to develop and evaluate the accelerated infringement notice procedure (commonly known as an instant fine) at the border. Statistics collected prior to and after the implementation of the notice procedure are used to evaluate its impact. The impact of the instant fine on the behaviour of passengers and crew is measured in terms of changes in the number of undeclared risk goods intercepted at the border. The combined effect of the infringement notice, x-ray of baggage and the biosecurity awareness programme have substantially reduced the number of passengers and crew with undeclared risk goods in their possession.

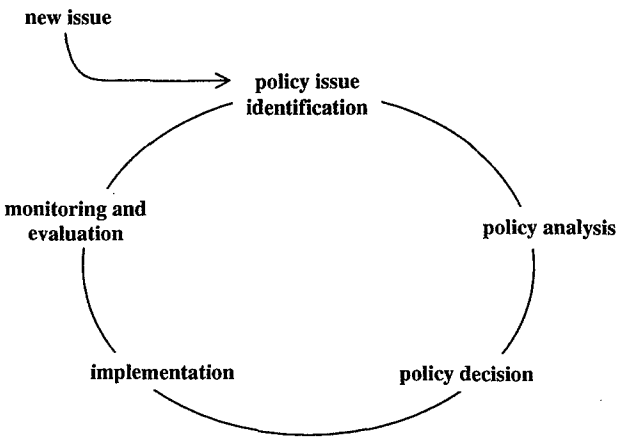
Keywords

Accelerated infringement notice, Passenger Arrival Card, false declaration, erroneous declaration.

Introduction

The policy process cycle consists of activities needed to make, implement and evaluate policy. The activities are policy issue identification, policy analysis, decision, implementation, monitoring and evaluation. The policy process was applied to the problem of the illegal introduction of undeclared risk goods by air and sea passengers and crew at the New Zealand border.

The policy process cycle



[1] The author wishes to acknowledge the advice and assistance of colleagues in the Ministry of Agriculture and Forestry. However, the views expressed in this paper are the responsibility of the author alone and are not necessarily the views of the Ministry of Agriculture and Forestry.

Policy issue identification

The New Zealand Passenger Arrival Card asks the following questions. Are you bringing into New Zealand:

- food of any kind?
- animals or animal products including: meat, honey, feathers, skins, eggs, dairy products, wool, bone, or cultures/biologicals?
- plants or plant products inlcuding: fruit, vegetables, flowers or foliage, seeds, bulbs, wood, bamboo, cane, or straw?
- other risk items including: used tents, tramping and hiking footwear, spiked sporting shoes, equipment/medicaton used with animals, soil, water and fishing equipment?

Passengers and crew are asked to tick yes or no to the above questions.

Some passengers and crew arriving in New Zealand fail to declare the above listed items in their possession. These goods may be risk goods because they may themselves be organisms or they may contain organisms that could cause damage to New Zealand. Undeclared risk goods represent a risk to biosecurity because if the goods were not detected and enter New Zealand, the goods or the organisms they contain, could create loss to production, biodiversity and human health. The presence of serious unwanted organisms in New Zealand is more likely to arise from passenger negligence than from goods imported through commercial channels.

Persons making a false declaration at the border could be prosecuted in the ordinary way. Prosecutions for offences under the Biosecurity Act section 154(b) are brought in cases where there has been a blatant attempt to smuggle goods, and evidence could be obtained to prove that the false declaration was made "knowingly", which is the *mens rea* element. Offences under section 154(b) carry maximum penalties of 12 months prison and $50,000 in fines. In other cases, where the evidence to prove the "knowingly" element can not be readily obtained, it is possible for MAF to bring a prosecution for an offence of erroneous declaration under section 154(s). Offences under section 154(s) do not have a mental element and carry a maximum penalty of a $400 fine, where not dealt with by way of the accelerated infringement notice procedure.

A survey was conducted and the results indicated that during one month 2151 persons were detected with undeclared risk goods. Resource limitations and the nature of the offences indicated that of the 2151 persons, 2 would be prosecuted in the ordinary way for a *mens rea* offence under section 154(b), seven would be prosecuted in the ordinary way under section 154(s), and the remaining 2142 persons would receive education letters/discussions or formal warnings. If an accelerated infringement notice system was in place, a majority of the 2142 persons would have been served with an infringement notice and incurred a $200 penalty. If an infringement notice system was not introduced, there would continue to be no enforcement response to the majority of erroneous declarations at the border.

Policy analysis

The large number of persons making an erroneous declaration at the border would be well beyond the capacity of both MAF and the court system to prosecute in the ordinary way. However, the resource requirements for operating an infringement notice system are

substantially smaller than those required to process a prosecution through the court. Consequently an infringement notice system could deal with the large numbers making an erroneous declaration. Such a response would be necessary to maintain a deterrent against erroneous declarations and would strike an appropriate balance between the practicalities of dealing with the high rate of detection and the need for appropriate safeguards to protect the rights of individuals. The purpose of the instant fine would be to encourage passengers and crew to declare any risk goods they may possess on their persons or in their baggage.

To assess the numbers of passengers and crew with undeclared risk goods and the logistical requirements to implement the infringement notice procedure, MAF Quarantine Service (MQS) conducted a survey of passenger arrivals at Auckland International Airport. The survey was conducted over the 35-week period 6 July 1998 to 1 March 1999 inclusive. The survey indicated that on average 510 persons per week had undeclared risk goods in their possession.

The three initiatives available to address the problem of undeclared risk goods were to:

- implement an education programme;
- invest in additional x-ray machines so that all accompanied baggage was x-rayed prior to clearance;
- implement the accelerated infringement notice (instant fine).

Policy decision

The continuing lack of compliance with the legal requirement to declare risk goods, by many people entering New Zealand, led to a decision to develop a targeted declaration offence, that could be proceeded with by an infringement notice that would be capable of rapid processing and payment to cater for international travellers. The purpose of the infringement notice was to:

- provide an incentive to comply with the law; and
- provide a deterrent to careless non compliance.

The decision to implement and fund the notice procedure needed to be made by Cabinet. Departments whose outputs may be affected and political parties in coalition needed to be consulted and any objections needed to be dealt with. The infringement notice proved to be controversial and consequently the decision process was quite protracted and more than a year was needed to obtain the level of agreement needed to make the decision.

Implementation

MAF determined that a total of 16 infringement unit staff were needed to implement the infringement notice provisions. This number of staff takes account of annual leave and staff training etc. Staff include 13.5 full time equivalent Quarantine Infringement Notice Officers (base location are, 7 in Auckland, 2.5 in Wellington, 3.5 in Christchurch and 0.5 at regional airports). These persons operate as a dedicated team 7 days a week to service all arrivals to New Zealand. Other staff include 1 infringement clerk, 1 cashier and 0.5 group leader. Court activity, when necessary is handled nationally by MAF's Enforcement Unit staff.

The notice procedure is being implemented at all airports currently receiving international arrivals i.e. Auckland, Wellington, Christchurch, Hamilton, Palmerston North, Queenstown and Dunedin. It has been implemented at Auckland, Wellington and Christchurch since 18 June 2001 and all others from 1 July 2001. Resources are currently adequate to cover every international flight, although staff absences and illness occasionally stretch resources at Auckland airport.

In May 2001 the biosecurity awareness campaign *Protect New Zealand* was commenced and in July 2001 the number of x-ray machines was increased so that all passengers either had their baggage x-rayed or they were interviewed. These later changes meant that the estimates of the impact were based on one environment and the results achieved in practice were based on a different environment.

Monitoring and evaluation

To monitor and evaluate the impact of the notice procedure, data was collected on the number of passengers with risk goods, the number of notices issued, the kind of risk goods and class of passenger. This information was analysed for the six months period from 18 June to 18 December 2001. The estimates made prior to implementation and actual implementation results for the six month period (26 weeks) ending 18 December 2001 are provided in table 1.

Table 1: Estimated and actual results of implementing the infringement notice procedure

Average per week	Survey (9 months to March 1999)	Actual (6 months to Dec 2001)
Total passengers and crew	60,424.00	70,136.00
Passengers and crew with undeclared risk goods	510.00	425.19
Infringement notices issued	350.00	191.35
Infringement notices not issued	161.50	228.58
Infringement notices cancelled	0	5.27
Infringement notices on which fees paid	300.00	170.46
Unpaid notices lodged with Department for Courts	50.00	15.62

The above data has been further analysed and performance measures used to facilitate a comparison between the results of the survey used to assess the environment prior to the impact of the notice procedure and the performance of the notice procedure (see table 2).

Table 2: Performance measures to compare the estimated and actual performance.

Measures of performance	Survey %	Actual %
Passengers and crew with undeclared risk goods/ all passengers and crew	0.84	0.61
P & C receiving notice/ P& C with undeclared risk goods	68.63	45.00
Infringement notices cancelled/ notices issued	0	2.83
Infringement notices paid/ notices issued	85.71	89.09
Notices unpaid/notices issued	14.29	8.16

The impact of the notice procedure on biosecurity risks

The impact being measured is the impact of the combined activities of the infringement notice, the x-ray of passenger baggage and the biosecurity awareness campaign. The key measure is the change in the percentage of passengers and crew detected with undeclared risk goods. This indicator has declined from 0.84% to 0.61% of passengers and crew detected with undeclared risk goods in their possession. Consequently the combined activities have reduced biosecurity risks from passengers and crew.

As the notice procedure and public awareness campaigns continue, the number of undeclared seizures, particularly the number not declared by NZ residents and English-speaking travellers, is expected to fall, further reducing the number of infringement notices issued. An increase in the declaration of risk goods rather than an increase in infringements, should be the measure of success for the notice procedure.

Infringement notices issued

The proportion of passengers and crew with undeclared risk goods that actually received a notice is much lower than was expected. The estimates based on the survey were that 68.63% of passengers and crew could be expected to receive a notice. In practice, 45% of those with undeclared risk goods did receive a notice. The reasons for the lower number of notices issued is continuing to be examined.

Reasons for not issuing infringement notices

The standard set by the Ministry of Agriculture and Forestry for implementation of the notice procedure provides that the following passengers may not, as a matter of normal procedure, be issued with an infringement notice:

- Passengers under 17 years of age.
- Passengers over 75 years of age.
- Passengers with no comprehension of the declaration requirements through language or other difficulties.
- Accredited diplomatic agents.

The reasons for non issue of a notice were investigated and recorded in a sample of 1572 passengers who were in possession of undeclared risk goods and did not receive a notice (see table 3).

Table 3: Reasons for not issuing an infringement notice to passengers with undeclared risk goods

Reason	Total	Percent
No/poor English	1234	78.50
Under age	98	6.23
Over age	54	3.44
Unaware of content	48	3.05
Verbal warning	40	2.54
Declaration issue	28	1.78
Enforcement Officer release	28	1.78
Did not pack bag	14	0.89
Prosecution	7	0.45
Domestic passengers	6	0.38
Humanitarian	4	0.25
Partner fined	4	0.25
NZ product	4	0.25
No enforcement officer present	2	0.13
Diplomat	1	0.06
Total	**1572**	**100.00**

The main reason why no notice was issued to some passengers relates to the standard set by MAF. The standard accounted for 88 percent of the recorded reasons for non issue of a notice.

Goods incurring an infringement notice

The most common type of goods for which infringement notices are issued was fruit fly host material making up 46% of the items for which infringement notices are issued. Stored food products make up 10%, contaminated equipment (mainly footwear) makes up 8%, meat products 7% and bee products 6%. Other types of risk goods account for less than 5% each.

Identity of those receiving notices

Table 4: Number of notices and rate of notices received by different nationalities to December 2001.

Nationality	Number of notices	Notices per 1000 travellers
New Zealand	1366	1.6
Australian	412	1.2
Asian and Middle East	839	9.0
Europeans	1050	7.3
African countries	51	5.5
North American	478	4.7
Japanese	342	4.5
Pacific Islanders	175	3.4
Central/South Americans	22	3.3
South-East Asian	240	3.2
Average of all nationalities		2.8
Total	**4975**	

Although New Zealanders have received the most notices (27% of all notices) compared with other nationalities, they make up nearly half of all the travellers entering New Zealand. Australia has the lowest rate of notices at 1.2 received per 1000 travellers and the rate of notices received by New Zealanders is 1.6 per 1000 travellers is the second-lowest of all nationalities.

Fees paid

The estimated financial impact of the notice procedure was based on an estimate that 86 percent of notices issued would be paid at the point of issue or within two weeks after the notice was issued. In practice 89.09 percent had paid at the end of the period and 92 percent of all notices had been paid within two weeks. This higher level of payment has resulted in fewer notices being passed to the Department for Courts for enforcement through the court process.

Financial implications

The difference between the estimated and the actual numbers of infringement notices issued and paid has impacted on the financial performance of the notice procedure. The net financial impact of the notice procedure is lower than had been anticipated because of the lower than anticipated number of notices issued. However, the notice procedure does make a positive contribution to Crown funds.

Appraisal

This description of the policy process for implementing the infringement notice has placed emphasis on the pre and post implementation evaluation. The evaluation of the infringement notice includes the impacts of both the increased x-ray of baggage and the biosecurity awareness campaigns which were implemented at approximately the same time as the notice procedure.

The post implementation evaluation resulted in some unexpected surprising differences from the pre implementation evaluation. The programme was more effective than anticipated at reducing the number of undeclared risk goods in the possession of passengers and crew. The impact of procedures at the border appears to have changed passenger behaviour. The proportion of fines paid was also higher than anticipated. However, the number of infringement notices issued to those with undeclared risk goods was much lower than anticipated. The lower than expected number of infringement notices issued is an issue that needs to be examined. Consequently a comprehensive review of the infringement notice is being under taken. The review is likely to indicate further issues for consideration leading to possible fine tuning of the policy.

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THE ECONOMICS OF HACCP (HAZARD ANALYSIS & CRITICAL CONTROL POINTS): A SURVEY

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Abstract

HACCP is a food safety management program which requires food companies to identify possible hazards, critical control points and critical limits for each hazard, responses in case of violations; and to monitor and record all procedures. As a combined approach of risk assessment and risk management, HACCP is increasingly adopted to prevent food safety hazards. HACCP brings benefits to the society by enhancing food safety and therefore reducing the number of foodborn illnesses. However, the program also brings social costs, such as industry compliance costs and administration costs. This paper focuses on the issues associated with the implementation of HACCP regulation. These issues include: (1) HACCP as a food safety regulation; (2) HACCP as a business management tool; (3) HACCP as an international trade standard; and (4) the impacts of HACCP on market structure and the distributional impacts. The paper concludes with implications for future research.

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Introduction

HACCP (pronounced hassip) or Hazard Analysis and Critical Control Points is a systemic approach to the identification, evaluation, and control of food safety hazards (National Advisory Committee on Microbiological Criteria for Foods (NACMCF), 1997). The approach was first started in 1959 with the Pillsbury Company's manufacture of food products for the NASA space program (Peirson, 1995). Since then, HACCP has been strongly suggested as an effective approach to prevent food safety hazards by many national and international scientific groups, corporations, government agencies and academic organizations (Peirson, 1995). The joint FAO/WHO Codex Alimentarius Commission (an international food standard-setting organization) endorsed HACCP in 1993.

HACCP has also been and being mandated into law in many nations all over the world. In the EU, HACCP was adopted through the Directive 93/43 in 1993 (Ziggers, 2000). In the US, HACCP was mandated for seafood in 1995, for meat and poultry in 1998, and for the juice industry in 2001 (FDA, 2001). Australia is considering a national food hygiene standard based on HACCP principles (Morrison et al, 1998). In New Zealand, the Animal Product Act 1999 requires all primary animal product processing businesses to have a HACCP-based risk management program in place by the end of the transitional periods (which is now extended to 2006 for some plants) (MAF, 2002).

The concept of HACCP is actually to focus on preventing hazards that could cause foodborn illnesses by applying science-based controls, from raw materials to finished products. It involves seven principles:

1. Conduct a hazard analysis, which involves collecting and evaluating information on hazards associated with the food under consideration to decide the

significant hazards to be addressed in the HACCP plan.

2. Determine the critical control points, which are steps where controls can be applied and is essential to prevent or eliminate or reduce a hazard to an acceptable level.

3. Establish critical limits, which are maximum/minimum values to which a biological, chemical, or physical parameter must be controlled at a CCP.

4. Establish monitoring procedures, which is to assess whether a CCP is under control and to produce an accurate record for future use in verification.

5. Establish corrective actions, in case there is a deviation from an established critical limit.

6. Establish verification procedures, which is to verify that the HACCP system is working correctly.

7. Establish record-keeping and documentation procedures, which is to document the HACCP system.

Each food establishment is required to have its own HACCP plan tailored to its individual products. Moreover, there are required prerequisite programs prior to the implementation of HACCP. Prerequisite programs such as Good Manufacturing Practices are said an essential foundation for the success of a HACCP plan (NACMCF, 1997).

As HACCP is increasingly used as food safety assurance program, concerns have been put forward about its effectiveness in enhancing food safety as well as the impacts it may have on the food markets, industry, and consumers. The purpose of this paper is to discuss issues associated with the adoption of HACCP and its impacts. Issues discussed include: (1) HACCP as food safety regulation; (2) benefits and costs of HACCP; (3) impacts on markets and distributional impacts; and (4) HACCP as an international trade standard. The paper concludes with implications for research.

HACCP as a food safety regulation

Government intervention in the food market is justified by the lack and high cost of information associated with food safety and the resulting consequences for public health (Unnevehr and Jensen, 1996). There are alternative interventions ranging from consumer education, mandatory labelling to statutory regulation, or even ex post regulation such as the liability system. Consumer education on safe food handling depends on their ability to make choices and their control over food safety (food at home vs. food away from home). Liability systems depend on the ability to trace back the source of problems. Statutory regulation is arguably a preferred approach. Statutory regulation could be in the form of process standards or performance standards. A process standard specifies the technology or procedures a firm must follow in production while a performance standard imposes requirements on the final product. Process standards do not allow firms to choose an efficient production technology and therefore is believed to be less efficient than performance standards. However, performance standards involve end product testing, which may be very costly as in the case of microbiological tests of meat products. This explains why HACCP is widely preferred as a process design to prevent food safety hazards. Moreover, HACCP also permits more efficient and effective government oversight (FDA, 2001). Thus, HACCP could be an efficient regulatory tool in spite of being a command-and-control process standard (Unnevehr and Jensen, 1996).

Is HACCP a cost-effective approach to food safety hazards?

There have been several studies on the benefits and costs of HACCP regulation (Crutchfield et al, 1997). In general, HACCP benefits to the society are reductions in risks of morbidity and mortality associated with consuming unsafe foods (Antle, 1999). Costs associated with these risks could be divided into: (1) costs of treating foodborn illnesses; (2) forgone income due to lost work time; (3) costs of averting illnesses; and (4) disutility of illnesses. Enhancing food safety would result in reductions in these costs. HACCP costs are usually divided into: (1) costs of implementation; and (2) costs of HACCP maintenance. Examples of costs of implementation are costs of HACCP planning and training employees. Maintenance costs could be costs of monitoring, sampling and testing, and costs associated with process modification.

The Food Safety Inspection Service (FSIS) of the US Department of Agriculture (USDA) used the cost-of-illness method to estimate the benefits of HACCP regulation for meat and poultry. The present value of medical costs and productivity losses due to foodborn illnesses associated with four main pathogens is estimated to be in the range of $1.9 to $171.8 billion over 20 years (Crutchfield et al, 1997). The lower bound was estimated with 7% discount rate, 20% reduction in illnesses, and using a lower value of a statistical life. The upper bound was associated with 3% discount rate, 90% reduction in illnesses, and a higher value of life. The cost-of-illness approach is said to provide the lower-bound estimate of HACCP benefits as consumers would be willing to pay for risk reduction even if they are not actually ill (Unnevehr, 1996). FSIS also estimated the costs of HACCP, which range from $1 to $1.2 billion over 20 years (Robert et al, 1996). Therefore FSIS concluded that HACCP results in positive net benefits in all scenarios (Crutchfield et al, 1997).

The study of FSIS however has received some criticisms. Firstly, FSIS's estimated costs are criticized as being underestimated (Robert et al, 1996; Belzer, 2000; Colatore and Caswell, 2000; Antle, 2000). Robert et al (1996) doubted that the estimated costs could be that low due to FSIS lacking data on process modification. Belzer (2000) also considered that the estimate was based on a sample of 9 establishments which was too small to represent the whole industry. Colatore and Caswell (2000) did an ex post estimate of the costs of HACCP in the breaded fish industry and concluded that ex ante estimates are usually underestimated due to the diversity of HACCP applications. The study of Antle (2000) provided an estimate of the increase in variable cost of production, which ranges from $535 million to $4.8 billion. This includes costs not captured in a normal accounting approach. Secondly, FSIS's estimate of HACCP benefits was based on debatable assumptions of HACCP effectiveness and the relationship between pathogen reduction and illness reduction. Further scientific knowledge about these relationships is required.

Whether or not HACCP bring net benefits still remained a unanswered question. As the cost-of-illness approach just provides a lower-bound estimate, benefits of reducing food safety risk are considered potentially much higher (Unnevehr and Jensen, 1996).

However, studies concerning the impacts of HACCP on food markets, industry structure, and distributional impacts are just emerging. This implies that careful consideration must be taken in measuring the benefits and costs of HACCP. As noted by Antle (2001), a short-run and static analysis could lead to misleading results.

Private incentives to adopt HACCP

It is important to note the motivation of firms adopting HACCP. Some researchers have noted that the costs of HACCP regulation could be reduced if firms, due to some private incentives, have already adopted HACCP in the absence of a regulation (Martin and Anderson, 2000).

There are several factors which motivate firms to adopt a quality management system such as HACCP. According to Holleran et al (1999), these factors could be grouped into internal and external factors. Internal factors consists of those such as improving product quality and shelf life, reducing product failure and wastage, or improving control of production process. External factors could be customer requirements, the desire to gain market share, or the threat of regulatory requirements.

A study of HACCP adoption in the UK industry shows that these firms adopt HACCP in order to meet customer requirements and legal requirements, and to gain improvement in operating efficiency (Henson and Holt, 2000). It is also argued that firms have incentives in reducing sanitary deficiencies due to the threat of huge costs involved in the event of loss of reputation from the sale of contaminated products (Ollinger, 2000). In the event of a food safety outbreak, firms may consider not just sale loss but also costs associated with tort liability, fines, potential future supply restrictions and stricter future government regulation (Worth, 2000).

HACCP as a business management tool

HACCP as a process design also functions as a management tool (Mazzocco, 1996; Cato, 2000). As a process control, it is a part of a system of total quality management which if implemented properly brings benefits to firms. These benefits include: (1) improving

operational efficiency; (2) reducing transaction costs; and (3) developing competitive advantage (Caswell et al, 1998; Bredahl et al., 2001; Farina and Reardon, 2000).

Nganje and Mazzocco (2000) conducted an efficiency analysis of HACCP in the (US) meat industry and concluded that: (1) firms have lower marginal costs compared with their marginal cost prior to HACCP implementation; (2) firms without HACCP systems are less cost efficient than firms with HACCP systems; and (3) firms with HACCP systems have greater technical efficiency than firms without HACCP systems. Their argument is that HACCP can improves allocative and technical efficiency by reducing product reworks and inefficiency in the use of inputs. The study of HACCP adoption in the UK dairy industry (Henson and Holt, 2000) also reported benefits such as reduction in wastage, increase product shelf life, and decrease in production costs.

Transaction costs are costs of undertaking an exchange between a customer (buyer) and a supplier (seller) (Holleran et al., 1999). Transaction costs include items such as costs of supplier identification, costs of contract negotiation, and costs of contract verification and enforcement. As Mazzocco (1996) has pointed out, through HACCP systems installed in suppliers' operations, firms are able to reduce costs of raw materials inspection, materials specification, raw materials inventory, and other costs associated with inputs. Such HACCP systems can also help to reduce the costs of searching for competent suppliers, thus reduce transaction costs. This phenomena of 'downstream costs, upstream benefits' has recently become an issue associated with food safety requirements.

It is also argued that transmitting HACCP system requirements to consumers or suppliers can also reduce marketing and sales costs (Cato, 2000; Mazzocco, 1996). By adopting a quality/food safety management system like HACCP and being able to signal it to consumers, firms can prevent the problem of imperfect information and enjoy a premium for the higher quality products. HACCP therefore brings marketing advantage. The use of HACCP as a marketing tool was also reported by Bungay (1999) who showed that Canadian HACCP-registered food businesses have requested permission to use advertising materials, labeling claims, and promotional materials. HACCP may also bring competitive advantages. Gain in international market access (export) will be discussed in the next section.

HACCP as an international trade standard

Over recent decades, traditional trade barriers such as tariffs have been reduced significantly through multilateral trade agreements. However, non-tariff barriers have proliferated. Food safety regulations, intentionally or unintentionally, can act as non-tariff barriers to trade. Studies have shown that food safety measures account for a significant portion of technical barriers to trade of agricultural and food products (Crutchfield et al., 2000). Unintentionally, the differences in food safety measures adopted by countries can have distorting effects on trade. Theses differences are results of the differences in countries' perceptions of food safety risks which in turn depend on many factors such as perception of science and risk assessments, knowledge and access to food technologies, and past experience with food safety incidents (Buzby, 2001; Crutchfield et al., 2000).

Attempts to manage the differences in food safety regulations are called rapprochement efforts. Strategies for rapprochement can be grouped into three categories: (1) harmonization, (2) mutual recognition, and (3) coordination (Hooker and Caswell, 1996; Henson and Caswell, 1999; Hooker, 1999). Harmonization involves the standardization of regulations in identical forms. Clearly, harmonization is the strongest effort. The bilateral agreement between Australia and New Zealand managed by the Australia New Zealand Food Authority (ANZFA) is often cited as one of this type (Hooker, 1999). Mutual recognition involves the acceptance of regulatory diversity as meeting common goals or equivalency. An example of this type is the rapprochement effort of the European Union (Hooker and Caswell, 1996). Coordination aims to gradually narrow the differences between regulatory systems, often based on voluntary international codes of practice. Examples of this type include those trade agreements of North American Free Trade Agreement (NAFTA) and World Trade Organization (WTO).

It is argued that the growing international use of HACCP should facilitate trade of food products once countries have adopted similar food safety assurance system (Caswell and Hookers, 1996). However, the degree to which HACCP could facilitate trade depends on the coordination efforts of nations. In other words, countries need to reconcile the differences in their HACCP regimes.

The flexibility of HACCP is a challenge to this harmonization task. HACCP is said to be a combination of performance and process standards (Antle, 1999; Unnevehr and Jensen, 1999). It could just be a performance standard if governments require its implementation but do not specify its details (Cato, 2000; Caswell and Hookers, 1996). On the other hand, it is a process standard when there are requirements of how it should be implemented. Thus, obviously HACCP as a performance standard will facilitate trade better than HACCP as a process standard.

Harmonizing HACCP regimes also require that the differences in their prerequisite requirements are reconciled. Prerequisite programs are the foundations for an effective HACCP (NACMCF, 1997). These programs often cover in detail the requirements of the environment for the production process regarding product quality and safety. Examples are Standard Sanitary Operating Procedures (SSOPs) and Good Manufacturing Practices (GMPs). Caswell and Hooker (1996) argued that prerequisite programs alone can pose non-tariff barriers to trade. They provided an example of the problem with prerequisite programs between Canadian HACCP regime and US HACCP regime.

In practice, there have been different degree of HACCP rapprochement. The EU has the strongest level of HACCP rapprochement, where HACCP-based regulatory regimes have been hamonised across countries (through EU Directive 93/43) (Caswell and Hooker, 1996; Ziggers, 2000). WTO and North American approaches to rapprochement for HACCP are weak forms of coordination. The WTO encourages member countries to adopt the Codex HACCP standards. However, Codex HACCP is just a set of minimum HACCP principles and does not provide detailed guidance on how it should be implemented (Caswell and Hooker, 1996). As a matter of fact, countries usually put in place programs which are stricter than Codex HACCP.

Once HACCP and prerequisite programs are coordinated, trade can be facilitated. Some recent studies have focused on the impacts of HACCP adoption on gains in trade (Zaibet, 2000; Alpay et al, 2001). Zaibet (2000) considered the relationship between compliance to HACCP and the competitiveness of Oman fish processing industry. Using an export model, in which firm export penetration index (measured as the proportion of export volume in total production) is a function of the status of HACCP adoption, sanitation

requirement, labor (number of employees), and capital stock; the study found that HACCP adoption has a positive impact on exporting.

Alpay et al (2001) studied the impacts of HACCP and other quality control systems on the export performance of Turkish food processing firms. Export value is specified as a function of the compliance with quality and safety standard, HACCP adoption, the compliance with environmental standards, the degree of vertical integration, and firm experience in the export markets. Although using a different approach to that of Zaibet (2000), the study also found a positive relationship between HACCP adoption and exporting.

The impacts on market structure and distributional impacts

It has been argued that small plants may bear a higher HACCP cost per unit than large plants, given their smaller production scale (Unnevehr, 1996; Robert et al, 1996). Therefore there are concerns that HACCP regulation would lead to small plants reducing the number of their products or even exit the market (Siebert et al, 2000; Muth et al, 2001). Using plant level data under federal inspection, the study of Muth et al (2001) compared the rate of plant entry and exit prior to and during the implementation stage of HACCP regulation (1996-2000). It was found that the rates of exit of meat slaughtering plants did increase during HACCP implementation, particularly for very small meat slaughtering plants* (from 12.5% to 20%). Through interviewing industry representatives and other HACCP expertise, the study found that small plants in fact made fewer changes in the production process than large plants. However, the authors argued that even unit costs are less for small plants, they may still exit at a faster rate due to lack of expertise in HACCP implementation or their revenues decreased such that their businesses were no longer profitable. Small businesses may have to cut down the number of their products, especially those with premiums. The loss of specialty, seasonal and ethnic products reduced their profitability. The study also examined the factors which contribute to the probability that a plant exits the market during HACCP implementation. Using a probit model, in which the probability of plant exit is a function of plant characteristics (e.g

*less than 10 employees or less than $2.5 million in sales.

slaughter volume, plant age, HACCP size), company characteristics (e.g number of plants), regional characteristics (e.g entry rate), and supply conditions (e.g wage rate, cattle price); the study found that HACCP size designation did affect the probability of exit. Small plants were 55% more likely to exit than large plants. It concluded that policy interventions should help to alleviate the economic effects of HACCP, especially for those plants with higher probability of exit.

Siebert et al (2000) studied the impacts of HACCP upon small and very small meat processors. Three models were constructed. The first model concerned the factors which affect the level of costs of implementing HACCP (e.g plant size, process complexity). The second model considered the probability of HACCP leading to products being withdrawn. The third model considered the number of products withdrawn due to HACCP. The study found that: (1) implementation costs are significantly related to the addition of new facilites, custom exempt status, and the starting date of required implementation; (2) Probability of product withdrawal is affected by the addition of new facility and staff due to HACCP and the require starting date; (3) the number of product withdrawal is also related to building or expansion of facilities due to HACCP and the number of items within a sales mix.

Distributional impacts

It is argued that the distribution of regulatory costs is also an important issue as it may affect the future industry structure (Unnevehr et al, 1998). This secondary impact is usually not included in the regulatory impact assessment and therefore is of concern to the subsequent studies (Unnevehr et al, 1998; Goodwin and Shiptsova, 2000).

Unnevehr et al (1998) argued that production cost rises due to regulations would lead to the supply curve shifting upward, thus increasing product price. Higher prices would lead to the substitution effects among products. For example, higher beef prices would lead to consumers shifting to other meat products such as pork and poultry or other non-meat products. This adjustment would lead to a new equilibrium in the meat markets. The

Small plants are those with 10 to 500 employees. Large plants are those with more than 500 employees.

authors then employed a multi-market model to measure changes in producer welfare by comparing the initial with final equilibrium. The study found significant producer welfare losses due to HACCP regulation. With the substitution effects among meat products, total meat producer welfare losses is in the range of $72 to $733 million per year. Losses of individual industry were $5 to $52 million, $24 to $263 million, and $40 to $426 million for poultry, pork, and beef producers respectively. Without substitution effects among meat products, producer welfare losses are even higher (total losses in this case is estimated in the rage $95 to $748 million. Poultry producers have the lowest losses as demand elasticity estimates show that consumers are in favour of poultry when the price of beef increases. The authors concluded that there are substantial producer welfare losses as product prices increase due to food safety regulation. Interestingly, in the case of the meat industry, these losses tend to be reduced with the substitution effects among meat products. This implies that the structure of demand has a significant influence on the actual market outcomes following regulation. There will also be consumer welfare losses as price increases, but according the authors these losses are insignificant compared with the benefits of reducing food safety risk.

Goodwin and Shiptsova (2000) studied producer welfare losses of the poultry industry due to HACCP regulation. Although using a similar framework as that of Unnevehr et al (1998), this study utilized ex post estimates of HACCP costs. The study also found a significant producer welfare loss, which ranges from $4 to $23 million without substitution effects to poultry products, and from $31 to $63 million per year when demand substitution is taken into account. Consumer welfare loss was estimated in the range of $49 to $73 million with substitution effects, and from $79 to $93 million without substitution effects.

Conclusion

The study has discussed the issues associated with the implementation of HACCP as a food safety management system. Overal, HACCP brings benefits to society by reducing costs associated with food safety risks, but also imposes costs on the food industry. HACCP could also function as a business management tool and have a positive influence

on firm export performance. Moreover, in the long term, HACCP could affect market structure and reduce producer surplus. As HACCP has just been introduced into the New Zealand food legislation system, the time is just right for a benefit-cost analysis of the system. This could be done for each individual industry which is required to have HACCP in place. Research should consider:

1. The benefits of HACCP as the reduction in costs associated with health risk;

2. The costs of HACCP, which include implementation costs, maintenance costs, and the impacts on productive efficiency;

3. The gain in exports due to the adoption of HACCP; and

4. Distributional impacts, impacts on different size of firm, and market structure changes due to HACCP.

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