

Papers Presented at the

NEW ZEALAND

AGRICULTURAL ECONOMICS SOCIETY (INC.)

FIRST ANNUAL CONFERENCE

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NZ Branch of the Australian Agricultural Economics Society*

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Welcome

Ladies and Gentlemen, friends and colleagues, student prize winners, members and guest, welcome to your nineteenth conference, but your first as the New Zealand Agricultural Economics Society Incorporated. Whether it be your nineteenth conference or your first I trust it will be an enjoyable time.

The theme of the conference this year is *1984-1994: Ten Years of Progress?* The last decade has seen considerable change to the New Zealand economy and the agricultural sector. We have seen significant changes in fiscal policy, monetary policy and the role of the state - changes to MAF, to universities to agricultural policy, to industrial policy and much more. These changes followed a period of extremely disappointing economic performance and were an attempt to do better.

Many of our members have been involved in these changes: some advocating policies, some interpreting policies, some criticising policies and some scrambling for reemployment as institutions changed.

In this period we have all had surprises. Some things have worked better than expected. Some things have worked even worse than expected. Some things have been resilient and survived with minimal change for good or for bad.

Now at the end of this decade, at a time when the Minister of Finance reports a budget surplus, it is opportune for us to reflect on what has happened. We are about to approach a new era with the advent of MMP and the associate changes to the political landscape. Before we become players on this new stage let us consider what has happened in recent years and what we have learnt.

So today I welcome our presenters of invited papers and our presenters of contributed papers and I welcome you all, to listen to question and to learn. Take the opportunities in the formal sessions and at other times to network and interact.

Finally, we have a programme. Please cooperate with the session chairpersons to see everything proceeds in an orderly manner.

So without further ado, I declare the conference open.

President's Report

It is my pleasure to present my report for the 1993/94 year. It has been a period of significant work and development although not a lot of public activity.

After at least five years of negotiations the New Zealand Agricultural Economics Society has finally been incorporated in New Zealand as a society affiliated with the Australian Agricultural Economics Society (AAES). This has involved considerable work revising draft constitutions, talking with the AAES and satisfying the Justice Department. I must acknowledge the significant work done by Rod Forbes in 1993 helping us to get to where we are. A copy of the constitution has been tabled at this meeting and I believe it provides us with the opportunities, recognition and freedoms as a New Zealand society while maintaining the advantages and minimising the disadvantages of links with the AAES.

Some of the highlights of the year were :

- During February we hosted the AAES annual conference in Wellington and again thanks are due to Robin Johnson and Rod Forbes for facilitating this important event. It was doubly appropriate we host this conference in 1994 as Robin Johnson was completing his term as AAES president.
- During September I attended the AAES Council meeting in Melbourne. I also attended Council meetings in Wellington in February and participated in a telephone meeting in May.
- The society has a team led by Margaret Wheatstone involved in the NZQA review of economics education in New Zealand.
- Robin Johnson is currently editing the Review of Marketing and Agricultural Economics.
- The Society has awarded three post graduate student awards in 1994 and also one undergraduate prize.
- The committee met once in November 1993 and has had infrequent discussions by telephone, email and facsimile.

At this time I think it is appropriate for the society to document some of its history before it is lost. I believe the society should ensure that conference proceedings from 1976 to 1993 are held in Lincoln University, Massey University, Waikato University and MAF libraries. Furthermore it would be helpful to document conference themes and committee members.

I would also like to remind members of the opportunities to attend the AAES meeting in Perth in February 1995.

It is also possible for members to publish articles in the Australian Journal of Agricultural Economics, The Review of Marketing and Agricultural Economics and New Zealand Economic Papers. It would be good if every year our best papers were submitted to these journals and hopefully some of them would receive a wider circulation.

Finally I would like to wish Sandra Martin and her committee all the best in 1994/95.

Frank Scrimgeour
1 July 1994.

SECTION A
INVITED PAPERS

MONETARY POLICY IN NEW ZEALAND: 10 YEARS OF PROGRESS

ARTHUR GRIMES
NATIONAL BANK OF NEW ZEALAND

JUNE 1994



1. INTRODUCTION

New Zealand monetary policy has undergone a revolution since 1984. Prior to then, the (multiple) objectives of monetary policy were unclear, and the control mechanisms relied on a regulatory rather than a market-based approach. Developments over the past decade have yielded a structure in which the (single) objective for monetary policy is clearly stated, and the control mechanisms are entirely market-based. Compared with other developed economies, New Zealand has moved from having one of the most regulated financial systems to one of the least regulated; and it has moved from having one of the highest inflation rates to one of the lowest.

This paper describes and analyses these shifts. Section 2 provides some background to the post-1984 experience. It examines New Zealand's long-term experience with monetary policy and inflation, with emphasis on the two decades leading up to the reform period. Developments in inflation and monetary policy are tied into developments elsewhere in the domestic economy, including fiscal policy. The importance of domestic financial regulation in the pre-reform period is stressed.

Developments are discussed also in the context of international developments and of exchange rate regimes adopted by the New Zealand authorities. New Zealand is a small country which is open to international trade. In the year to March 1993, exports and imports respectively constituted 31 percent and 29 percent of Gross Domestic Product. Because of this factor, New Zealand's inflation rate is affected significantly by inflationary developments in its principal trading partners (Australia, Japan, United States, United Kingdom and Germany). Periods when New Zealand's inflation rate has either followed world inflation trends or diverged from them have generally corresponded to different exchange rate and monetary policy regimes. When New Zealand has maintained a fixed exchange rate, its inflation has corresponded closely to world inflation rates, whereas when the exchange rate has been more flexible, inflation has tended to deviate from world rates.

Section 3 discusses the approach of the "reformers" (government and officials) in the post-1984 period. It stresses the *ideas* that drove the reforms. These include some (although far from all) of the key conclusions of the "monetarist" school and, later, the key insights of the time inconsistency literature. It also explores the influence on the monetary policy reforms of concurrent policies relating to public sector management structures and accountabilities. The Reserve Bank of New Zealand Act, 1989 was the culmination of these influences. The key aspects of this Act are described in Section 4.

Section 5 describes the methods used by the Reserve Bank to implement monetary policy since the reform process began, highlighting the changes in the nature of these methods through the period. In Section 6, we examine criticisms of monetary policy and of the Reserve Bank Act raised by some economists through the reform period. The theoretical views underlying these criticisms are outlined. These provide a contrast with the theories which underlay the design of the Act itself. We examine economic outcomes over recent



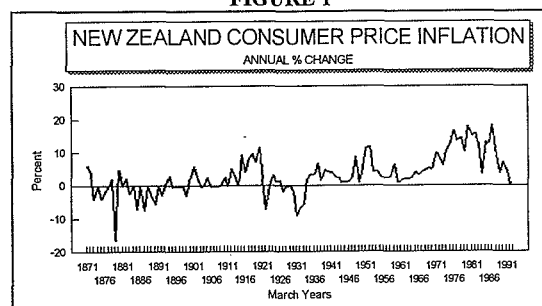
years to distinguish which (if either) of these approaches has best described events since the Reserve Bank Act was passed.

Section 7 concludes with a discussion of the key lessons that have been learned over the past 10 years with regard to monetary policy design and implementation.

2. NEW ZEALAND'S INFLATION EXPERIENCE

Data for New Zealand's rate of consumer price inflation extends back to 1871. Figure 1 graphs the annual CPI inflation rate from that date onwards. A number of broad trends are apparent. In the period through to the start of World War Two, inflation averaged close to zero; from the start of the war until the mid-1960's, inflation averaged approximately 4 percent; it trended upwards from the mid-1960's until the mid-1980's, reaching a peak of 18.9 percent in June 1987; finally, it fell sharply in the late 1980's and early 1990's to its current level of below 2 percent. These inflation trends correspond to distinct monetary policy and exchange rate regimes.

FIGURE 1



Pre-World War I

Until 1914, New Zealand was on the gold standard. The law required bank notes to be convertible into gold on demand. The effect was that the New Zealand currency had a fixed exchange rate both with gold and with the currencies of other countries tied to gold. The New Zealand price level was determined by the world-wide supply of gold relative to the world-wide production of goods. The period was characterized internationally by virtually zero inflation on average over time, albeit with significant fluctuations (upwards and downwards) in the price level. These characteristics were shared by the New Zealand price level.

World War I - World War II

New Zealand, along with the United Kingdom, left the gold standard at the outbreak of World War One. It did not return to it formally after the war, but it did maintain a *de facto* fixed exchange rate with the United Kingdom, which in turn returned to the gold standard. Inflation rose during the war period, but fell back to again average close to zero during the inter-war years. The inter-war period was, however, characterized by sharp fluctuations in the price level. Following the inflation during and immediately after World War One, prices fell sharply and were to fall again sharply during the Great Depression beginning in 1929.

This experience led the New Zealand Government in the mid-1930's to introduce legislation designed to enable New Zealand to run an independent monetary policy. The Reserve Bank of New Zealand was created in 1934 initially with private ownership, but was then nationalised by the incoming 1935 Labour Government. The fixed exchange rate with Sterling was formalised and at the same time, strict exchange controls were implemented. These were designed to allow Government to expand lending in New Zealand while preventing an otherwise inevitable foreign exchange outflow.

In addition to these policies, Government increasingly accessed credit from the Reserve Bank (effectively printing money to cover a portion of its deficit), and controlled interest rates both on its own borrowing and more generally through the economy. It attempted to control the resulting inflationary pressures by limiting the credit creation ability of banks through a number of regulatory devices. Under these policies, inflation rose in the late 1930's to around 5 percent.

World War II-July 1984

Inflationary pressures increased further during World War Two (as evidenced by double digit growth in the money supply) but price inflation was temporarily held in check by strict wartime price controls. When these controls were lifted after the war, inflation rose briefly to 10 percent before falling back to low single figures. The world-wide inflation associated with the Korean War again caused inflation to rise briefly into double digits, before falling back to an average of 4 percent up to the mid-1960's.

This rate of inflation was the highest continued rate New Zealand (and indeed most other countries) had experienced in its history outside of wartime. It was similar to the United Kingdom experience over this period, which in large part was attributable to the maintenance of the fixed link with Sterling. Given this fixed link, New Zealand's inflation rate could not deviate significantly from that in the United Kingdom and instead the strong inflationary pressures which resulted from the expansionary domestic monetary policies became increasingly exhibited through the rationing of credit domestically, and through periodic balance of payments problems.



The United Kingdom's inflationary and balance of payments problems resulted in it devaluing by 14.3 percent relative to the United States dollar in November 1967. New Zealand, which also had severe balance of payments and inflationary pressures, devalued by 19.45 percent at the same time (to bring the New Zealand dollar to parity with the Australian dollar). The devaluation caused a subsequent increase in New Zealand inflation which reached 5.8 percent in the year to March 1969.

This period marked the start of a worldwide increase in inflation. This was a trend which New Zealand shared, and in fact amplified. New Zealand's inflation rate remained on an upward trend through to the early-1980's. Between 1970 and 1982, New Zealand's inflation rate averaged 12.8 percent, considerably higher than its main trading partners. The key factor which pushed New Zealand's inflation higher than the world average over this period was the behaviour of Government whose expenditure rose from 29 percent of GDP in 1974 to 38 percent in 1987. Government deficits were particularly large in the first half of the 1980's. In the five years to March 1985, the government's financial deficit averaged 4.8% of GDP, reaching a peak of 6.5% of GDP in 1984. Part of the extra government expenditure was financed through borrowing from the Reserve Bank, resulting in strong monetary growth. Between 1972 and 1987, M3 growth averaged 17% per annum.

In the post-war period until 1984, the New Zealand government attempted to run a monetary policy that was independent of the rest of the world. Government's primary policy aim was to maintain full employment and a key component of its policies to implement this was to run an expansionary monetary policy. It maintained interest rate controls (of fluctuating intensities through the period) combined with compulsory reserve requirements on financial institutions designed to force these institutions to lend to government at below-market interest rates. Banks were directed, through government regulations, to lend to favoured sectors (such as agriculture) in preference to other sectors. The result of these policies was extensive credit rationing within New Zealand, combined with lower real interest rates on average in New Zealand than elsewhere; O'Donovan (1994) finds that real government bond rates in New Zealand averaged between 1 and 1.5 percent below those in Australia and the United States over the 1945-1993 period. The foreign exchange controls erected in the 1930's were an integral part in maintaining this policy approach, since they prevented the immediate capital outflow that would have occurred with New Zealand's low interest rate structure.

New Zealand maintained international competitiveness in the face of its fast increase in domestic costs by embarking on periodic devaluations of its currency. Devaluations occurred in December 1971, September 1974, August 1975, November 1976 and June 1979. The overall effect of these devaluations was that the New Zealand dollar depreciated by 11.5 percent against a trade-weighted basket of currencies between June 1971 and June 1979. At that point, New Zealand embarked on a "crawling peg" exchange rate system, whereby it devalued monthly according to the difference in its inflation rate and that of its trading partners. This system resulted in a trade-weighted depreciation of 16.6 percent between July 1979 and June 1982, when the system was halted and the

country returned to a fixed exchange rate. Even under this supposedly fixed rate, domestic inflationary pressures were such that the exchange rate had to be devalued again in March 1983 by 6 percent.

For the whole 1967-1982 period, New Zealand had effectively been on an inflation treadmill. Strong domestic inflationary pressures caused Government to devalue the exchange rate to maintain international competitiveness, but the devaluation then fed back into domestic inflationary pressures, so causing a further devaluation and further inflation.

Faced with this high inflation, Government periodically attempted to introduce wage and/or price controls, but these had little effect beyond the short term. The most comprehensive of these controls was the 1982-84 wage and price freeze (which was associated also with the maintenance of a fixed exchange rate, intensified credit controls on banks and strict interest rate controls). This freeze succeeded in reducing inflation to 3.5 percent in March 1984, but resulted in many pricing anomalies and other manifestations of inflationary pressures, such as a current account deficit equal to 6.9% of GDP over the 1982-85 period.

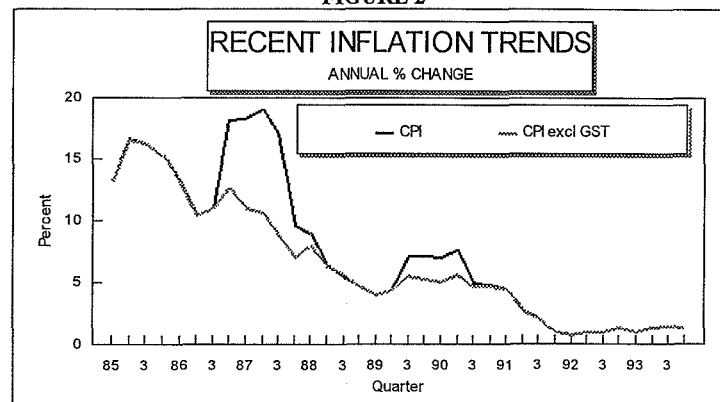
Post-July 1984

In July 1984, the incoming Government made the control of inflation a high priority for economic policy. However, the dropping of the freeze, coupled with the decision to devalue the exchange rate by 20 percent in July 1984, saw inflation rise sharply to 16.6 percent in June 1985. From this time onwards, however, Government has been intent not only on controlling inflation, but also in doing so through conventional market-oriented policies. Initially, the Reserve Bank was frustrated in its efforts to control the monetary aggregates because the fixed exchange rate and newly opened international capital market prevented it from raising interest rates sufficiently to put downward pressure on inflation.

The floating of the currency in March 1985 was the key initiative that enabled the New Zealand authorities to run an independent monetary policy aimed at controlling inflation. From this time onwards, monetary policy has been aimed explicitly at reducing inflation until price stability was ultimately achieved. In the 1988 Budget Statement, the Minister of Finance went further by announcing the Government's intention to introduce legislation to make the Reserve Bank more independent of Government in achieving its price stability goal. The major aspects of this legislation are discussed in more detail in section 4.



FIGURE 2



The effects of the anti-inflationary monetary policies are apparent in Figure 2. Inflation trended down remarkably smoothly throughout the June 1985 to December 1991 period, excluding the effects associated with the introduction in October 1986 of the 10 percent Goods and Services Tax (GST) - a form of value added tax - and of the subsequent increase in this tax to 12.5 percent in July 1989. The introduction and raising of GST caused both the headline CPI inflation rate to increase, and also caused a temporary halt to the reduction in inflation exclusive of the GST effect, as wage and price setters temporarily questioned whether inflation would continue to fall following the impact on prices of the tax. In each case, however, inflation (inclusive and exclusive of GST) resumed its fall once the GST effect had passed through the annual inflation figures.

Since December 1991, the annual rate of inflation has remained within the Reserve Bank's target band of 0-2 percent at all times. It is the case, however, that inflation fell faster in 1991 than the Reserve Bank had either expected or intended. Indeed, the Reserve Bank under-shot its published transitional target for inflation in that year. This undershooting points to the fact that the authorities do not have direct control over inflation. Instead, the Reserve Bank influences financial markets variables and must estimate how these effects will ultimately feed through to inflation in future years.

3. IDEAS UNDERLYING THE REFORMS

Official advisers to government had privately criticised the approach to monetary policy for a number of years prior to the election of the new government in July 1984. The incoming government - particularly the Finance Minister, Roger Douglas - also were critical of the prevailing method of implementing policy. The advent of the new government was therefore an appropriate opportunity to implement a new monetary policy regime.

Monetary policy officials had both macroeconomic and microeconomic goals in mind. Foremost amongst their ultimate policy concerns were their macroeconomic goals:

"The ultimate objective of monetary policy is the maximisation of non-inflationary economic growth." (Tweedie, 1986, p.48.)

In order to achieve this goal, officials had to outline an appropriate macroeconomic framework to follow, and an appropriate microeconomic framework in which to operate:

"The various monetary policy measures ... are part of an overall package which has two broad objectives:

1. *At a macroeconomic level, a desire to put in place a framework for monetary policy which gives the authorities effective control over domestic monetary conditions.*
2. *At a microeconomic level, a concern that government intervention in the area of monetary policy should be implemented in a way which encourages the development of an efficient financial sector." (Tweedie, 1986, p.53.)*

While the Reserve Bank stated that "non-inflationary growth" was the ultimate aim of monetary policy, the discussion in Tweedie (1986) and Deane (1986) placed heavy emphasis on the "non-inflationary" aspect of this aim. The importance for monetary policy and for inflation control of funding the government's deficit through bond sales, rather than through borrowing from the Reserve Bank, was highlighted early in the reforms:

"The principal objective of monetary policy, as now embodied primarily in the public debt sales programme, is to achieve suitably moderate and steady rates of growth in the major monetary aggregates. Underlying this aim, of course, is the wish to influence the ultimate economic objectives and, in particular, over the longer term to reduce the rate of inflation and to maximise the rate of increase in real national income." (Deane, 1986, p.23.)

The intellectual approach underlying these extracts is undoubtedly "monetarist" in character (Friedman, 1968). The importance of "facilitating an improved degree of control over the monetary base and, ultimately, the money supply"¹ is in keeping with monetarist orthodoxy. So too was the emphasis on adopting market-based methods of monetary control as opposed to the previous regulatory controls. This is where the microeconomic objectives came to the fore.

In keeping with other economic policy reforms of the period, policy-makers chose to abolish almost all financial sector regulations. Within a period of nine months after the

¹Deane (1986), p.15.



July 1984 election, all interest rate controls, foreign exchange controls, ratio requirements on banks and other financial institutions and credit ceilings were abolished, and the exchange rate was floated. Monetary policy implementation focused on controlling the monetary base (termed "primary liquidity") through periodic government stock tenders and through daily open market operations. Changes in primary liquidity were expected to feed through into (unconstrained) interest rate movements, which would spread through to changes in the exchange rate, the money stock and aggregate demand and thence on to the final variables of interest, notably inflation.

Despite the broad monetarist tenor of both the macroeconomic and microeconomic approach that was adopted, this was not a full-blown monetarist experiment. In fact, the cornerstone of the monetarist prescription - the targeting of a set rate of growth in one of the monetary aggregates - was never adopted in New Zealand during the post-1984 period. (Ironically, it had been adopted during the earlier, regulated period, making this period in some ways more "monetarist" than the later era.)

The reticence in adopting the monetary targeting approach stemmed from the rapid structural changes in the financial sector that were occurring at the time. The removal of the regulations caused significant reintermediation to occur. Previously the regulations had caused much borrowing and lending to be conducted through fringe intermediaries (such as lawyers). With the removal of controls, this business was redirected towards the traditional banking sector. Thus the monetary aggregates grew very quickly in the initial stages of the reform period: in the three years following June 1984, M3 grew at an annual rate of 23 percent.

5

This reintermediation effect on monetary aggregate growth caused the Reserve Bank to decide not to publish any monetary aggregate targets and instead to monitor a "checklist of indicators". However the monetary aggregates were still the key stated indicators in the early stages of reform, and early comments implied that monetary targets could well be adopted subsequently:

"it has been decided at this stage not to publish any particular targets for the usual money supply indicators but instead to concentrate analysis on a range of medium and short-term indicators of monetary conditions. The medium term intermediate targets which the Bank monitors include the narrow money supply M1, the broader money supply M3, private sector credit, and 'primary liquidity'."
(Deane, 1986, pp.23-24, emphasis added.)²

The fact that the only medium term intermediate targets mentioned in this article were the various monetary and credit aggregates, and that targets had not been adopted *at this stage* imply that it was very much a monetarist approach that was envisaged despite the lack of published monetary targets. It was expected that targets would be published once

the relationships between the monetary aggregates and the key nominal target variables (the CPI and/or nominal GDP) settled down.

In the event, however, no clear patterns between monetary growth and subsequent inflationary developments have appeared (Wong and Grimes, 1992). No monetary growth targets have ever been published, and instead the Reserve Bank turned increasingly towards monitoring other indicators in addition to the monetary aggregates, notably the exchange rate and the level and structure of the yield curve.

From late 1988 onwards, the trade-weighted exchange rate (TWI) came to prominence as the major monetary indicator. The Reserve Bank regarded the linkages between the TWI and CPI inflation to be stronger than between the CPI and any other (leading) monetary indicator. Grimes and Wong (1994) produce empirical evidence substantiating this view; particularly contrasting the performance of the exchange rate with the money supply in this regard. The importance of having an indicator that links closely in with inflation was intensified as the Reserve Bank increasingly came to concentrate explicitly on inflation as the sole ultimate target for monetary policy.

This view on the appropriate ultimate target for policy reflected more than just the traditional monetarist influence. It was influenced particularly by the literature on the potential time inconsistency of monetary policy [for example, Barro and Gordon (1983)]. Briefly, this literature implied that a monetary authority which attempted to target both inflation and a real sector outcome (such as production or employment) had the incentive to persuade agents that it would pursue a low inflation policy, but would then adopt a more expansionary monetary policy than stated in order to achieve its real sector goal. Rational agents would anticipate this occurring and so would adjust their inflation expectations upwards in advance of the monetary policy outcome. If the authorities acted as anticipated, inflation would rise to the expected level, and there would be no real sector gains since all contracts would have been entered into at the expected level of prices and costs. If the authorities stuck to their announced target, inflation would turn out to be lower than expected but there would be negative real sector consequences as agents were surprised by the tightness of policy.

In line with these theoretical insights, the existence of multiple objectives for monetary policy within the existing Reserve Bank of New Zealand Act combined with the historically prolonged high inflation rate (which meant that the Reserve Bank had no established anti-inflationary credentials) made it difficult to convince agents that inflation was headed sustainably towards low levels. This was in spite of stated government policies that monetary policy was being targeted to contain inflation over the medium term.

Measured inflation expectations averaged considerably above actual inflation outcomes through the late-1980s. This can be seen through the National Bank of New Zealand survey of inflation expectations (of approximately 1,500 small to medium sized businesses). This survey showed year ahead inflation expectations standing at 14.1% and

²This article was initially written in December 1984, and updated in May 1985.



10.0% respectively in March 1987 and March 1988. Actual inflation in the following years (to March 1988 and March 1989) turned out to be 7.4% and 4.1% respectively, or approximately half the expected levels.

The time inconsistency literature suggests that while these expectations turned out to be materially incorrect, they were in fact quite rational in *ex ante* terms. Economic agents had seen successive governments espousing a low inflation policy only to backtrack on such a policy and end up running high inflation. The previous backtracking was invariably done without announcing a policy that higher inflation would in fact be pursued. Given that the Reserve Bank had yet to have a sufficient period to establish its reputation as being focused solely on containing inflation, and given the multiple objectives within the Reserve Bank Act there was a substantial positive probability in economic agents' minds that monetary policy would revert towards a more expansionary stance. This is exactly as predicted by the time inconsistency literature. It was to address these problems and to put in place a sustainable policy environment that changes were made to the Reserve Bank Act.

4. THE RBNZ ACT

The Reserve Bank of New Zealand Act 1989 (which became law in February 1990) is the legislation which specifies the monetary policy responsibilities of the Reserve Bank. While the monetary policy aspects of the legislation are focused specifically on the control of inflation, the Act is best understood as being part of a broader package of economic policies and public sector reforms.

These broader reforms sought to make public sector organisations more accountable by giving them clearer and more publicly observable objectives, as well as by improving public reporting standards and clarifying the responsibilities of individuals (particularly Chief Executives) within public sector organisations. In this light, the Bank's Governor (rather than its Board of Directors) was made responsible for the achievement of the targets set for the Bank. The Governor has to release a Monetary Policy Statement at least every 6 months discussing the Bank's conduct of monetary policy over the preceding 6 months and discussing how it intends to conduct monetary policy in the future. This Statement is released publicly, is tabled in Parliament, and the Bank's Governor appears before the Finance and Expenditure Select Committee of Parliament to discuss its contents.

The Government's broader economic policies sought to remove price and other distortions within the economy and set in place a medium term focus for policy. Consistent with this approach and with the policy views outlined in the previous section, Government considered that the principal medium term effect of monetary policy was to influence the price level, with little medium term effect on other variables (such as growth or employment). Indeed, because of time inconsistency considerations the inclusion of other such variables in the Bank's objectives would be harmful - both for the achievement of

inflation and real sector outcomes. It decided therefore to focus monetary policy on controlling inflation and to relieve it of its previous additional duties of influencing trends in employment, trade and production.

The key feature of the Reserve Bank Act is that monetary policy has the sole objective of controlling inflation. This is set out in Section 8 of the Act:

8. Primary function of the Bank - The primary function of the Bank is to formulate and implement monetary policy directed to the economic objective of achieving and maintaining stability in the general level of prices.

Section 12 of the Act allows for a mechanism to change the economic objective for monetary policy away from price stability to any other objective for a period of 12 months (renewable any number of times). This must be done through an Order in Council (effectively a Cabinet decision), which has to be tabled in Parliament. Government therefore retains the right to decide the objective to be pursued by monetary policy, but now has to make this objective known publicly, which had hitherto never been required.

This Section is intended primarily for use in times of emergency (such as wartime) when short term inflationary financing may be required by Government. The key is that any change to the objective is known publicly and so investors can react in full knowledge of the Government's plans. No use has been made of this section since the Act was passed. Further, it is unlikely that Government would seek to use this section except in an emergency as the financial markets would be likely to raise interest rates immediately the section was activated, making it an unpalatable avenue to be pursued by any Government.

The Act does not define the exact meaning of "stability in the general level of prices". This is left to the Policy Targets Agreement (PTA). This is a publicly released agreement between the Minister of Finance and the Governor of the Bank which is required by the legislation. Its role is to specify precise targets for the Bank to follow in carrying out its monetary policy responsibilities.

A new PTA is signed between the Minister and the Governor at the time of a Governor's appointment to cover the Governor's term of office (five years). The terms of the PTA must be compatible with the Act, so preventing the parties to the agreement from substituting targets that are in conflict with the specified economic objective. Except where an Order in Council has been passed changing the economic objective for monetary policy, any change to the PTA prior to its expiry must be by mutual agreement of the Minister and the Governor, and must be released publicly upon signing. In the event of the use of Section 12 of the Act, a new PTA has to be agreed between the Minister and the Governor within 30 days to cover the period specified in the Order in Council.

It is in the PTA that the 0-2 percent inflation target has been specified. The first target was signed on 2 March 1990 following the passage of the Act. It required the Bank to pursue monetary policy aimed at achieving price stability by the year ending December



1992. Price stability was defined as an annual rate of inflation, measured by the All Groups Consumers Price Index, in the range of 0-2 percent. Once achieved, price stability was to be maintained thereafter.

The PTA also specified certain situations where the price stability target might legitimately not be met. These caveats covered two principal areas. The first was major relative price shocks arising from such factors as a natural disaster or from a major change in the terms of trade. The latter might be driven for instance by a sharp shift in oil prices or in the prices of exported commodities. This area also covered divergences between the CPI's treatment of housing costs (inclusive of interest rate effects and the cost of existing houses) and the Reserve Bank's preferred measure of housing costs (based on an imputed rental approach) as measured in its published Housing Adjusted Price Index (HAPI). The second situation covered the impact of changes in indirect taxes (especially GST) or significant changes to other Government charges. In each case, it was envisaged that the appropriate response was for the Reserve Bank to target an inflation rate excluding the direct effects arising from these factors, but to ensure that second round pricing impacts did not occur.

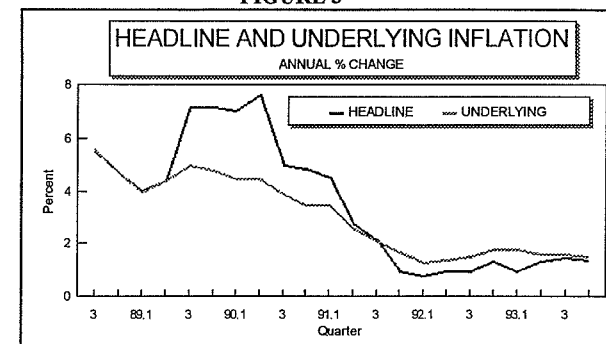
The PTA has been revised twice subsequently. Upon taking office in 1990, the new National Government sought the Governor's agreement to extend the date when achievement of price stability was required to December 1993 (a delay of one year). A new PTA was signed to this effect on 19 December 1990. This PTA also made minor, but not material, changes to the caveats.

A new PTA was signed when the Governor was reappointed in December 1992. This was signed on 16 December 1992. With price stability already having been achieved, the key change in this document was to remove a date for the achievement of price stability. In its place is a requirement that price stability (0-2 percent inflation) be maintained henceforth at all times on a four quarter basis. The nature of the caveats remained broadly as before except that the treatment of housing costs was changed to refer to a divergence between the All Groups CPI and the CPI excluding the interest costs component.

The specification of the targets in the PTA means that the Reserve Bank, in effect, targets "underlying inflation" rather than the published (or "headline") rate of CPI inflation. In calculating its underlying inflation rate, the Reserve Bank adjusts the published CPI for significant price movements caused by changes in commodity prices, government charges or interest rates. The significance level is generally taken to be any change that has an effect on the CPI of at least one quarter of one percent. This has entailed it adjusting for such effects as rising oil prices at the time of the Kuwait war, rising timber prices and falling petrol prices in 1993, the raising of certain Government charges and interest rate effects. Figure 3 graphs the Reserve Bank's underlying inflation rate against the headline CPI inflation rate since 1988. The deviations of the underlying from the headline inflation rate have been in both an upward and a downward direction at different times.



FIGURE 3



One significant feature of the Reserve Bank's concentration on underlying inflation is that CPI inflation may well deviate from the 0-2 percent range without necessarily attracting a Reserve bank response to prevent this from occurring. Any deviation from the target band should, however, be short-lived and inflation should return to the 0-2 percent band over time.

5. MONETARY POLICY IMPLEMENTATION

Monetary policy implementation procedures changed not only at the time that the reforms began, but have changed also through the reform period. The current implementation procedures are outlined in some detail below and are then contrasted with implementation approaches earlier in the reform period. The reasons for the modifications through this period are explored.

Current Practice

In recent years (essentially post-September 1988), the Reserve Bank has adopted an explicitly forward looking approach to policy in order to achieve its inflation target. It considers that the major effects of monetary policy changes on the price level occur over a period of 6 to 24 months after the change in policy. It therefore does not attempt to control inflation outcomes over the next one to two quarters, believing these to be determined already by past influences. Instead, it focuses on controlling inflation 2 to 8 quarters ahead.

The Reserve Bank's approach is to forecast inflationary influences over this horizon arising from such factors as unit labour costs, domestic demand pressures, and world price movements as reflected in the foreign currency price of imports and exports. These inflationary influences are regarded, at least in the short-term, as being either wholly or



largely independent of monetary policy influence. The impact of these factors on inflation is calculated, given existing monetary conditions (i.e. existing interest and exchange rates).

The resulting forecast inflation rate may or may not be within the desired 0-2 percent target band. In order to bring forecast inflation within this range, the Reserve Bank derives an appropriate band for the trade-weighted exchange rate index (TWI). This band is calculated given the Reserve Bank's assumptions of how exchange rate changes impact on movements in the CPI. The Bank sets its exchange rate band according to the exchange rates that will give an inflation outcome of 0-2 percent in the forecast period, given the other forecast influences on inflation.

In practice, the forecast impact of the non-monetary factors on inflation tends to evolve only slowly over time. This has the effect of making the Reserve Bank's target band for the exchange rate also evolve slowly over time. The result is therefore a substantial degree of stability in the TWI. If the forecasting process involves the Reserve Bank requiring a shift in the exchange rate from existing levels, it seeks to achieve this through market mechanisms by influencing short-term interest rates. It has not used any foreign exchange intervention since it floated the exchange rate in March 1985.

The Bank does not have a separate target for interest rates, seeing interest rate changes as principally a means to influence the exchange rate and aggregate demand, thereby influencing the inflation rate. This is similar to its attitude concerning the exchange rate where the Bank has no independent target for the exchange rate other than the rate which will deliver 0-2 percent inflation given the other inflationary influences. With regard to interest rates, the Reserve Bank does seek to incorporate any independent effect of interest rate changes on inflation when deriving the appropriate exchange rate band, but in practice they have been able to find little such impact and so downplay this feedback effect.

Unlike other central banks, the Reserve Bank does not set any interest rates itself. Its discount rate and interest rate which it pays on banks' deposits with it are set daily by a given margin above or below the existing cash market rate. In order to influence interest rates it instead alters the quantity of cash reserves (Settlement Cash) it leaves in the banking system after its daily Open Market Operation. It can also alter the quantity of discountable securities (Reserve Bank Bills) it auctions or alter the discount margin used to set the discount rate relative to the cash market rate.

This approach does not result in precision regarding movements in short-term interest rates consequent on a policy change. Market interest rates are free to evolve in the absence of any administratively determined interest rate by the central bank. In practice, this normally means that market participants themselves shift interest rates and the exchange rate to levels consistent with delivering the Reserve Bank's target inflation band, generally obviating the need for the Reserve Bank to take explicit action.

This system of monetary policy implementation relies crucially on the Reserve Bank's ability to forecast inflationary influences. It uses a system of equations to explain the linkages between the various inflationary influences and CPI inflation. The key inflationary influences are cost factors including unit labour costs, the world price of imports, the world price of exports and the trade-weighted exchange rate. It supplements these cost factors with the influence of a number of demand factors.

This is essentially a "cost-plus" approach and contrasts with a "monetarist" approach in which the key focus would be on the influence of movements in monetary aggregates on inflation. The Reserve Bank estimates inflation over the succeeding two quarters by a judgmental approach based on estimating the likely price changes in the components of the CPI at a disaggregated level. Beyond that time horizon, it uses its equation system to predict inflation for approximately 80 percent of the CPI; the other 20 percent (covering volatile components such as fresh fruit and vegetables, interest rates and government charges) is estimated judgmentally (Schoefisch, 1993).

The equation system predicts that a 1 percent rise in unit labour costs will feed through directly, albeit over time, to a 0.5 percent rise in the CPI; a 1 percent rise in the world price of imported goods will feed through to a 0.21 percent rise in the CPI; and a 1 percent rise in the world price of exported goods will feed through to a 0.08 percent rise in the CPI. In addition, these cost influences will feed through indirectly to the 20 percent of the CPI not explained within the equation system. The effect of a 1 percent rise in the TWI, after including the direct effects plus the indirect effect on the 20 percent of the CPI not explained by the equations, is estimated to be a fall in the CPI (mostly within one year) of 0.32 percent. Demand factors which are estimated econometrically to impact (temporarily) on inflation are changes in retail sales, inventories and capacity utilisation.

This framework can be used to explain how the Reserve Bank reacts to an increase in one of the cost factors. For instance, if inflation was initially on track for 1 percent (the mid-point of the target band) and wages were then to rise by 1 percent relative to their previous path, the Reserve Bank would be forced to tighten policy. In broad terms, given that the impact of wages on inflation is approximately twice that of the exchange rate, the Bank would seek to engineer a 2 percent rise in the TWI relative to its previous target track in order to offset the inflationary impact of the wage increase. Alternatively, if the world price of imports and exports were both to rise by 1 percent relative to their previous path, the exchange rate (which has an impact equal to the sum of the import and export price impacts) would have to appreciate by 1 percent relative to its former target track. In practice, the Reserve Bank would seek to quantify the exact timing effects on inflation of the various cost changes and the impact of any induced demand effects arising from its policy actions in determining the exchange rate changes required in each of these circumstances.



Earlier Approaches

The current approach to policy implementation differs from that envisaged at the start of the reform process. The prevailing "monetarist" view of Reserve Bank officials at that stage translated into a view that targeting a narrow monetary aggregate would, over time, stabilise movements in broader monetary aggregates, nominal GDP and the price level. Therefore a sustained low rate of growth in a narrow monetary aggregate should translate through to sustained low inflation. Initially, there was considerable sympathy with Friedman's view that the links between changes in the monetary aggregates and inflation were "long and variable". Hence initially the Reserve Bank eschewed short-term stabilisation mechanisms within the monetary policy implementation structure.

Two immediate problems arose with this approach following its adoption in July 1984. Firstly, the maintenance of a fixed exchange rate prevented the monetary authorities from stabilising the monetary base and influencing interest rates. The Reserve Bank outlined the problems it had in running an independent monetary policy in these circumstances:

"Once exchange controls were removed in late December 1984, there was potentially little scope for an independent monetary policy so long as the fixed rate regime was maintained. As suitable channels for offshore investment were developed, private capital flows and the timing of trade finance flows quickly became more responsive to interest differentials. Domestic interest rates became more closely related to foreign rates ... In this environment the stance of monetary policy, as reflected in the size of the government stock tender programme, had limited direct impact on the level of interest rates. Attempts to run a relatively tight policy, for example, through accelerated debt sales, merely resulted in a private capital inflow and a switch in the structure of the public debt from foreign to domestic liabilities." (Spencer, 1986, p.144.)³

The problems to which Spencer refers led the Reserve Bank to float the exchange rate in March 1985. This enabled it to control the monetary base through its open market operations in conjunction with the government stock tender programme, so solving the first of the two major problems it faced with its newly adopted implementation approach.

The definition of the monetary base that the Reserve Bank chose to target was "primary liquidity", which consists of "settlement cash" plus "discountable securities". Settlement cash is the quantity of overnight cash deposited by banks with the Reserve Bank which is used to settle daily banking system flows. It is subject to flows between government and the banking system. At times these flows lead to periods when the banking system has no available cash to settle their flows without discounting securities with the Reserve Bank. Banks can access cash by discounting any discountable security. Initially, these comprised all government securities (Treasury Bills and bonds) with up to six months to maturity.

In the early period of the float, the second implementation problem was highlighted. The belief that monetary policy should not be "activist" led to an initial reluctance to stabilise either settlement cash or primary liquidity on a daily basis. The disappearance of the safety valve of the foreign exchange window, resulted in the banking system's liquidity became subject at times to severe pressures as a result of flows from the banking system to government. Settlement cash frequently fell to zero causing banks to discount securities with the Reserve Bank in order to settle daily flows. The size of these flows meant that at times banks had to incur considerable discounting costs.

There was an additional problem resulting from the quantity of discountable securities being highly variable over time due to the seasonal nature of the government's financing requirements (and hence of the outstanding quantity of government securities of less than six months to maturity). Hence Primary Liquidity was also highly volatile. The effect of these factors was to cause significant volatility in the costs of discounting and hence in the liquidity of the banking system. This in turn caused significant volatility in short term wholesale interest rates.

As a result of these pressures, the entire interest rate structure and the exchange rate also became highly volatile (see Table 1, discussed further below). This volatility was considered disruptive by domestic producers, especially exporters, and policy-makers came to accept the need for more activist management of banking system liquidity.

Acceptance of the strongly monetarist approach to policy also waned. Officials began to place less conceptual and empirical importance on changes in the monetary base (and the broader monetary aggregates). Reintermediation, caused by the regulatory changes, came on top of all other "more standard" instabilities in money demand to render the monetary aggregates poor indicators of developments in inflation and nominal activity. In addition, the extraordinary instability in the level of Primary Liquidity meant that no reliable relationships could possibly be ascertained between the key operating target (Primary Liquidity) and either the broader money supply or nominal activity; nor was there any sign of stability between a more conventional measure of the monetary base (the stock of currency) and either M3 or nominal GDP. Subsequent research within the Reserve Bank was to confirm the lack of stable relationships between any definition of the money supply (or the monetary base) and the price level or nominal GDP (Wong and Grimes, 1992).

The realization of these factors had two results in terms of the policy process. Firstly, officials explicitly adopted a "checklist" approach to monitoring monetary conditions (Spencer, 1992). This meant that officials looked not just at developments in the monetary aggregates but also at interest rate and exchange rate developments, as well as developments in other real and nominal economic variables to guide policy. This reflected the contemporaneous approach being adopted in Australia.

The second shift was associated with changes to the Reserve Bank's liquidity management regime in December 1985 (Ledingham, 1986). The Bank changed the definition of

³Spencer noted that a similar situation existed even whilst exchange controls were in force, citing the period leading up to the July 1984 devaluation when the existing exchange controls were not an effective barrier against speculative capital flows as the sophistication of the financial markets increased.



discountable securities (to government securities with less than one month to maturity) in an effort to reduce the seasonal component of primary liquidity. More importantly, it took a more activist approach to stabilising the level of settlement cash in the banking system. Thus from this point onwards, it used its daily open market operations to target a set quantity of settlement cash. This led to a reduction in the volatility of interest and exchange rates compared with the earlier regime.

The approach to stabilising the level of settlement cash has since been maintained. However, the level of primary liquidity continued to be highly volatile because of the seasonal nature of government's financing, which fed through to large changes in the level of government securities with less than one month to maturity on issue. This factor led to the subsequent issuing of a special Reserve Bank Bill which was tendered in set quantities, and which became the sole discountable instrument in November 1988. From this time onwards the levels of settlement cash and of discountable securities have both ceased to be volatile, so imparting less volatility to financial prices.

The move to the checklist approach to policy was not as durable. The problem with the approach was its lack of a recognizable framework. Even given a clear ultimate target, it was not clear (to observers or officials) just how the alternative variables should be interpreted and how they should be weighted in terms of their importance in determining ultimate outcomes. For instance, if at any time short-term interest rates rose, long term interest rates remained unchanged, the exchange rate fell, monetary aggregate growth fell while credit growth rose, how would all this be synthesised to reflect what was likely to happen to inflation? In practice, these quandaries arose frequently.

The problem became intensified as the ultimate target for monetary policy became more clearly specified. The two percentage point band-width in the inflation target made it more important for the Reserve Bank to have a framework which related its actions and its indicators tightly to resulting inflation outcomes. It was this imperative that led to the adoption of the current policy framework outlined in the first part of this section. The Reserve Bank made use of its econometric evidence on the determination of inflation and worked back from these relationships to yield a framework to guide the settings of its policy instruments.

Effects of the Implementation Changes

The moves made to refine the implementation process through the reform period had the effect of progressively reducing volatility in both the nominal exchange rate (the TWI) and in short term interest rates such as the overnight (cash) interest rate and the 90 day bank bill rate. Table 1 summarises these shifts in volatility. It presents the standard deviation of daily changes in the cash and 90 day interest rates and of daily changes in the logarithm of the TWI (the latter standard deviation is multiplied by 100). The first period chosen corresponds to the initial post-float period (excluding March 1985 when volatility was extraordinarily high and so would otherwise dominate the volatility statistics). It ends in December 1985 once the new system of liquidity management was implemented. The



second period dates from the end of the first period until September 1988 - which may be termed the "checklist" period. At the end of this period, the current approach to policy (with heavier reliance on the exchange rate) came into being. The third period dates from the advent of this policy approach until the present.

Table 1: Standard Deviations of Daily Movements

Period	TWI	Cash Rate	90 Day Rate
Apr 85 - Dec 85	1.17	3.71	0.29
Jan 86 - Sep 88	0.94	1.28	0.31
Oct 88 - May 94	0.44	0.58	0.12

From Table 1, it is noticeable that the shift in liquidity management regime in December 1985 had a very strong stabilising influence on the cash rate, which hitherto had an extraordinarily high standard deviation of daily changes of 3.7 percentage points. This was cut to a third of that level in the second period, although this was still high in international terms. The liquidity reforms had little effect, however, on volatility in the 90 day rate which was influenced by broader swings in the monetary settings; nor did exchange rate volatility decrease strongly.

The new approach to policy after September 1988, had the effect of reducing volatility in each of these variables. Not surprisingly, exchange rate volatility was cut by over a half with the new regime. Interest rate volatility was also reduced strongly, as the Reserve Bank sought to implement more stable short-term interest rates in order to obtain a less volatile exchange rate in line with its inflation target.

The overall effect of the changes through the reform period has been the maintenance of a "monetarist" ultimate target, in the sense that monetary policy aims at maintaining price stability. But the method of reaching this target is very "unmonetarist" in character, placing little emphasis on developments in the monetary aggregates as an indicator for policy. The latter aspect is similar to trends in most other countries through the 1980s and so in that sense is far from unique. The exact format of the current implementation process is however unique.

6. MONETARY POLICY CRITICISMS

The monetary policy framework has evolved over the past 10 years. There has been a shift away from emphasizing monetary aggregates to the present system which elevates the nominal exchange rate to a higher level of importance. The institutional structure has also evolved to the point where the Reserve Bank is independent to implement policy in order to achieve the single objective of price stability. These developments have occurred in a reasonably systematic manner, and throughout the reform process there has been a



certain consistency in the overall policy thrust: policy has concentrated on containing inflation through the use of market mechanisms.

However, these reforms have not met with universal approval. Criticisms have come at three levels. Firstly, the nature of the Reserve Bank Act - particularly the feature which gives operating independence to the Reserve Bank - has been questioned (Buckle and Stemp, 1991). They focus on the lack of co-ordination between monetary and fiscal policy that may arise with the current structure. This criticism relates to that of Sargent and Wallace (1984) whereby monetary policy may be ineffective in the presence of an unsustainable fiscal policy. In such circumstances, the pursuit of a conventional anti-inflationary monetary policy may be costly or even counter-productive in terms of controlling inflation. The point made by Buckle and Stemp is specific to the type of model which they choose to adopt. There is no evidence to suggest that there has been conflict between the monetary and fiscal authorities since the Reserve Bank Act was passed; consequently, while of theoretical interest, the potential problems which they raise are difficult to evaluate empirically.

The second level of criticism comes with disagreements over the optimal method of monetary control. There have been criticisms that the current operating framework concentrates too much on the exchange rate and not enough on monetary aggregates. It was in response to these types of issues that empirical work was conducted to test the "exchange rate based" approach versus a "monetary aggregate based" approach to monetary policy implementation (Grimes and Wong, 1994). The tests published in that paper demonstrate quite conclusively that a simple operating rule based on use of the exchange rate within a Purchasing Power Parity theoretical context would have considerably outperformed a monetary targeting rule based on the quantity theory relationship. Given that the Reserve Bank operating methodology is an enhanced version of the PPP approach it is expected to outperform even this approach and hence to considerably outperform a monetary targeting approach. There is no evidence in the New Zealand context to the contrary.

The third level of criticism was the one that raised the most comment through the late 1980s. This criticism contended that New Zealand could not successfully implement a monetary policy that sought to achieve a lower inflation rate than that of its trading partners. If it attempted to do so, it could at best *temporarily* suppress New Zealand inflation, and in doing so, the real exchange rate and real interest rates would be forced upwards. As long as the policy was maintained, the real exchange rate would remain at an artificially high level and so constrain real sector activity, particularly in the traded goods sector. Whitwell (1987, pp.279ff) is the clearest in this respect:

"theoretical and empirical considerations ... suggest that inflation in New Zealand is of the inertial variety, that is, the type of inflation which continues indefinitely in a predominantly administered price economy in the face of imported inflationary pressures. New Zealand's inflation rate will therefore tend towards the rate that prevails in the rest of the world, whatever the actions of the

policy-makers. To attempt to hasten the present inherent downward trend by maintaining upward pressure on the exchange rate through a high interest rate policy is, in the long run, counter-productive because of the adverse effects on the traded goods sector ... Its use of the interest rate structure to curb inflationary pressures through an appreciating exchange rate will have, at best, only a transitory impact on the long run rate of inflation."

Underlying this view is a theory which asserts that domestic prices and costs, particularly wages, are not responsive to domestic demand factors. Thus no matter what the level of unemployment, wages will continue to grow at recent rates of inflation. Prices, in turn will be influenced both by domestic factors (especially wages) and by international price trends reflected in import and export prices. This theory predicts the following sequence of events given an anti-inflationary strategy of the type adopted in New Zealand from the late-1980s onwards:

- (i) New Zealand's inflation is initially at a higher rate than in its trading partners. New Zealand authorities wish to bring inflation to a level which is below that prevailing overseas.
- (ii) The Reserve Bank raises domestic interest rates to bring down the inflation rate, and this pushes New Zealand's nominal and real exchange rate upwards.
- (iii) The higher exchange rate reduces the influence of imported inflation on New Zealand, since the NZ dollar price of traded goods is lowered.
- (iv) This effect brings down the CPI inflation rate gradually. However wages still increase according to past rates of CPI increase. As a result, real wages rise and the real exchange rate continues to rise.
- (v) Two choices exist at this point:
 - (a) Either the exchange rate keeps appreciating, in which case New Zealand can hold to a lower inflation rate than the rest of the world, but with real wages and a real exchange rate that are permanently too high to re-establish full employment, and with a traded goods sector that is decimated by the high real exchange rate.
 - (b) Alternatively, the exchange rate stops appreciating, import and export prices in NZ dollars rise at the rate of world traded goods inflation; wages revert to rising at this rate; and New Zealand's inflation rate converges back to world levels.

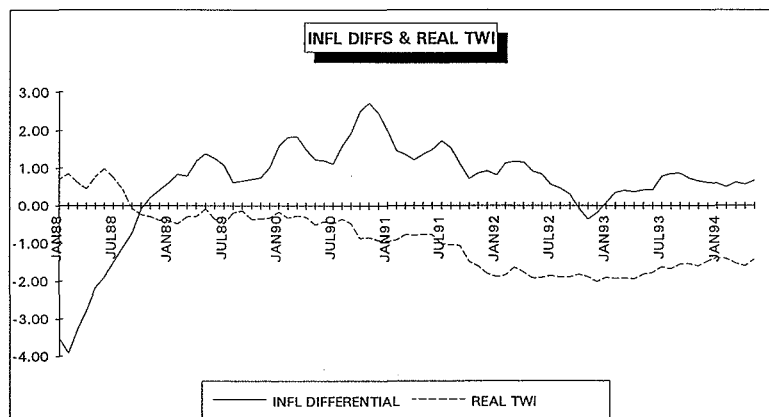
The hypothesis that New Zealand can only temporarily reduce its inflation rate below world levels implies that the second of these two alternatives is assumed to take precedence at some stage.



The official (Reserve Bank) view corresponds with the above approach to the fourth step. It differs, however, as to the response of domestic price behaviour thereafter. Once the real wage and real exchange rate disequilibrium occurs, the Reserve Bank view is that domestic costs will moderate as a result of domestic price developments *and* in response to domestic demand (especially unemployment) conditions. The fall in real wages that results from this process re-establishes an appropriate real exchange rate over time and enables unemployment to return to its equilibrium level.

To test which approach best accords with the actual reform process, we plot, in Figure 4, the differential between New Zealand inflation and that of our major trading partners (as per the TWI), together with the real exchange rate with those trading partners⁴. If the Reserve Bank view is correct, we would expect to see the real exchange rate rise initially at the same time as the inflation differential begins to close, and then to revert back to a more competitive (lower) level over time. If the "critical" view is correct, the initial exchange rate move will be seen, but there will be no reversion back to more competitive levels. Alternatively, the inflation differential will disappear.

FIGURE 4



In Figure 4 we do see the initially high real exchange rate as the inflation differential closes through 1988. From late 1988, New Zealand's inflation falls below that of its trading partners, and remains below international inflation almost continuously thereafter. Indeed,

⁴The real TWI compares the trade weighted CPI with the NZ CPI (excluding GST) adjusted for TWI movements. An increase in the series is a real appreciation of the NZ dollar (i.e. a loss of competitiveness for NZ). The Inflation Differential is the rate of "world" (i.e. TWI country) inflation less NZ inflation expressed in annual percentage terms.



rather than New Zealand inflation converging on other countries' rates, it was New Zealand that led the downward charge in inflation.

Most importantly, these trends were accompanied by an increasingly competitive real exchange rate for New Zealand. These developments brought New Zealand's real exchange rate down to its most sustained level of competitiveness since at least the 1950s. Between October 1991 and May 1994, the real TWI was, on average 14% more competitive than its average over the January 1975-June 1984 period. It was even within 1% of the extraordinarily competitive level which it reached in the year following the July 1984 devaluation. The period from October 1991 onwards contrasts with the period from July 1985 to September 1991, when the real TWI returned to its 1975-84 average level. This period of a relatively high real exchange rate coincided with the bulk of the disinflationary programme, whereas the post-September 1991 period coincides with the period when price stability has been bedded in.

The early developments are consistent with both the Reserve Bank and the critical views of the effects of monetary policy. However the latter developments are completely inconsistent with the critical view. In particular, New Zealand's inflation rate has now remained below world inflation almost continuously for close to six years, and over this period, the real exchange rate has fallen to a level well below its long run average. Since late 1991, in particular, New Zealand has maintained a lower than average inflation rate and simultaneously placed itself into a very competitive position against its international trading partners.

7. SUMMARY

New Zealand's history has generally been one of higher inflation than the world average. This was particularly the case from the mid-1960's to the mid-1980's. During this period, government spending grew strongly and was partly funded by borrowing from the Reserve Bank. The resulting inflationary and balance of payments pressures led to successive devaluations of the New Zealand dollar which in turn placed upward pressure on inflation and caused further exchange rate devaluations.

The inflationary spiral was broken in the mid-1980's with the move to use monetary policy to target price stability. A further milestone was the passage of the Reserve Bank of New Zealand Act 1989, which gave the Reserve Bank the duty to achieve price stability and the independence to do so.

New Zealand now has one of the lowest inflation rates in the world, having held inflation to below 2 percent over the past three years. This outcome is consistent with the target of the Reserve Bank which has the responsibility of keeping inflation within the 0-2 percent band. The process of reducing inflation to these levels has been far from costless. In



particular, the real exchange rate rose sharply in the mid-1980s placing considerable pressure on the profitability of the traded goods sector.

Over the past four years, these trends have reversed. New Zealand now has a real exchange rate that is extremely competitive compared with historical standards. The move to a more competitive exchange rate has accompanied the maintenance of inflation within the 0-2% band, considerably below the average inflation rate of our trading partners. The fact that this has occurred demonstrates that domestic pricing behaviour has adapted to the low inflation regime instituted formally with the Reserve Bank Act.

The recent strong growth in non-traditional exports, GDP and employment is also evidence that the low inflation regime that has been implemented is far from inimical to growth. Instead, it was the process of reaching price stability that was costly. These results are consistent with international evidence presented in Grimes (1991) that very low inflation is beneficial for growth, whereas the disinflationary process incurs temporary costs. The lesson from this study is that once price stability is achieved there is little to gain - and plenty to lose - by re-inflating. A number of other developed countries (especially Britain and Australia) made the mistake in the late 1980s of allowing inflation to rise again once it had been brought down to low levels. The costs that they incurred in once again having to bring their inflation rates down were severe recessions. The Reserve Bank Act should provide an effective bulwark against this mistake being made in New Zealand.



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RESOURCE MANAGEMENT 1984-1994

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The study of alternative rules for governing the use and management of natural resources derives much of its importance from the values that individuals attach to environmental amenities and opportunity costs of the large expenditures associated with service supply. In New Zealand the supply of environmental amenities is provided by organisations financed to a large degree by general tax revenue.

Prior to the reforms introduced during the 1980s legislation and government policy directed public agencies toward noncommensurable multiple objectives underpinned by a decision making process that was steeply hierarchical and centralised. A reasonably high level of public dissatisfaction with the environmental outcomes produced a degree of cohesion among environmental groups who combined forces to actively support the reforms. These reforms produced significant changes to the structure and functions of resource management agencies and environmental policy. Many of these arrangements were quite innovative in the field of public sector organisation. At the national level state owned enterprises (SOEs) were formed to fulfil commercial functions, preservation functions were incorporated into the Department of Conservation, and the Ministry for the Environment was established as a policy advisory unit.

I have been asked to discuss these reforms. There are two sections to the paper. The first section summarises the reforms and advances the hypothesis that the outcomes depend *inter alia* on institutional structure and the policy framework. The second section discusses the Resource Management Act 1991 and its administration.

INSTITUTIONAL CHANGE

The Crown is the dominant owner, perhaps I should say presumed owner, of natural resources in New Zealand. It is, on the basis of this right, along with the other rights given to Ministers of the Crown and their agencies, that they can exercise considerable power over the development and use of natural resources. In short, the Crown is the single most important institutional arrangement in natural resource management and environmental policy in New Zealand today. Sole rights to petroleum and geothermal resources are vested in the Crown; most minerals are reserved to the Crown; water is vested in the Crown; and large blocks of land are vested in the Crown.

At a highly abstract level, the outcomes associated with institutional reform can be summarised as follows:

Resources $\otimes$ Preferences $\otimes$ Institutions = Outcomes

where $\otimes$ = an abstract operator

This equation underscores the fact that institutional change is one potent variable in the economy (Plott, 1979). It is a variable that constrains activities of individuals; influences expectations and is the object of change through voluntary negotiations and political pressure. Theoretical and empirical research will improve our understanding of the abstract operator $\otimes$, in this respect New Zealand provides a superb laboratory for research.

Institutions are rules governing behaviour. These rules are variables derived from statutes, law and customs. Their particular significance in resource management derives from the observation that individual expectations are based on the behaviour of others playing the game. For example, individual expectations formed under an open-access fishery differ from those existing under a controlled fishery. Of equal significance is the fact that these rules are variables and the object of pressures for change. The distribution of the benefits has a very strong influence on the demand for institutional change. Change can originate from voluntary negotiation, legislation and the use of coercive power.

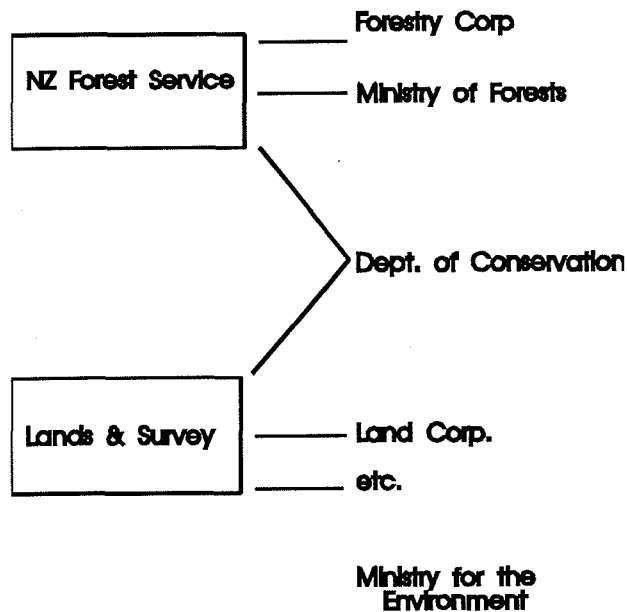


Figure 1: Reorganisation of Land Management Agencies

Figure 1 illustrates the reorganisation of land management agencies. Established by the Forestry Act 1921, the New Zealand Forest Service contributed to the development of a plantation forest estate, it established a research institute, created a system of state forest parks and provided policy advice to government. Similarly, the Department of Lands and Survey was formed in 1876 to contribute to the settlement and development of the country, the development of a national park and reserves system, a survey and mapping system and provide policy advice to government. Before the reforms these two government departments administered approximately 1/2 of the area of NZ. Other government departments were directly involved in administering and developing mineral and water resources.

These agencies were expected to satisfy multiple objectives set within a bureaucratic/political framework. This requirement created a massive demand for information on input-output relationships and prices. In many instances the response to a lack of information was to create complex administrative structures and procedures which, in general, failed to produce critical information on opportunity costs and the benefits of service supply. Few natural resource prices emerged out of these procedures. If the pricing mechanism was used, prices were administered and not determined by the forces of supply and demand. These administered prices did not reflect the realities of scarcity. A zero price was attached to water in water-short regions and many resource commodities, such as coal and stumpage, were supplied at prices below their extraction cost. The institutional framework did not use incentive compatible instruments (e.g. auctions) to encourage individuals to reveal their willingness-to-pay for natural resources. In summary, the incentives necessary for efficient resource use were lacking. Dissatisfied with the performance of multipurpose agencies, coupled with a desire to reduce the public sector deficit, the Labour government restructured the natural resource organisations. Figure 1 shows the exchange of organisational structures that occurred in 1987. Government expected the reforms to produce a positive sum gain.

Table 1 shows the financial contribution of the Crown (i.e. from tax revenues) to outputs produced by four environmental agencies. Excluding the Parliamentary Commissioner for the Environment, the Crown contributes around 80-90% of the revenue. Service supply agreements specifying outputs, establish a contract between Ministers of the Crown and providers. Any link between willingness-to-pay for service supply and the source of funds financing supply is extremely tenuous. Information on what a decision maker sacrifices when one alternative is selected (more endangered species preservation) rather than another (additions to parks) must come from sources which seek to combine individual preferences and scientific judgements. I have no doubts about the intent of decision making, my comments are directed at the difficulties posed by the decision making environment.

State-owned enterprise is an organisation which produces and sells goods, and whose assets are owned by the state. It is distinguished from public agencies because of its commercial focus. Although SOEs have a commercial focus they are part of a government structure and the political system which exposes them to direct political pressure. At the local level of government, local authority trading enterprises (LATEs) have been established to sell products to the local public. From the outset it is

essential to note that SOEs and LATEs should be considered alongside government and politics. Important structural questions involve the degree to which management and control is separated and the often cascading sequence of contracts that link the political sector with SOE/LATE decision makers. There may be no clear boundary between an SOE/LATE and the market. For example, partial exclusion of the capital market attenuates the efficiency of investment by exposing decision making to politics. These organisations are open, to varying degrees, to political influence.

Table 1: Operating statements of selected environmental agencies

Operating Statement	Department of Conservation (\$000)	Ministry for the Environment (\$000)	Ministry of Forestry (\$000)	Parliamentary Commissioner for the Environment (\$000)
Revenue				
Crown	100,846	9,876	8,105	1,040
Other	19,200	120	5,292	0
Interest	800	70	180	8
Other	0	5	0	0
Total Revenue	120,846	10,072	13,577	1,048
Expenses				
Personnel	61,500	5,423	6,100	653
Operating	44,854	3,861	5,745	357
Depreciation	5,800	385	460	20
Capital charge	7,892	104	312	0
Other	2,600	0	20	0
Total Expenses	122,646	9,773	12,637	1,030
Surplus/(Deficit) From Outputs	1,800	298	940	18

Source: Estimates of Annual Appropriations and Departmental Budgets of the Government of New Zealand for Year Ending 30 June 1994

Prior to 1991 the regulatory framework governing resource use was complex, expensive, lengthy and adversarial. The Resource Management Act 1991 was designed to economise on these.

THE RESOURCE MANAGEMENT ACT 1991

The purpose of the Resource Management Act 1991 is to promote sustainable management of natural and physical resources. Section 5 defines sustainable management in terms of use-rates of environmental resources that enable individuals and communities to provide for their social, economic and cultural well-being, subject to:

- i) sustaining resources to meet reasonable needs into the future
- ii) protecting the functioning of life-supporting environmental systems
- iii) avoiding, reducing or remedying adverse effects on the environment.

In particular, the Act seeks to promote planning and management that focuses on effects rather than the uses of environmental resources. Consistent with this concern for effects is the view that the rules and instruments of planning should be permissive and developed in relation to effects. Therefore, provided the basic principles outlined in s.5 are satisfied, administrators of the Act are expected to deal with effects rather than the activities possible. For example, a regional plan may expressly allow for transferable water permits. Whether a water permit, upon transfer, is used to obtain water for irrigating pasture or crops is irrelevant provided of course the basic criterion of sustainability is satisfied.

Property rights and prices are relevant to the three constraints for sustainable management. First, consider the goal of managing resources in a such a way that the reasonable needs of future generations are satisfied. The basic question to ask here is: what are the rights of the current generation *vis-a-vis* future generations? Clearly the current generation holds a monopoly in respect of rights. The duty we, the current generation, are willing to accept *vis-a-vis* future generations depends on our willingness to establish institutions for sustainable management. The Act provides a statutory basis for these institutions (e.g. tradeable water permits) to evolve.

Second, consider the goal of protecting the functioning of life-supporting ecosystems. At issue here is the rate at which environmental assets are utilised. Many renewable resources can sustain use for an indefinite period, provided the sustainable rate of use does not exceed the regenerative capacity of the system. In most cases there is usually more than one sustainable use rate and mechanisms can be applied to encourage efficient use.

Finally, consider the goal of avoiding, reducing or remedying adverse effects of activities on the environment. If the external costs are not priced in the market then those visiting damages on others will not take the full costs associated with their decisions into account. Moreover, consumers of the products will pay only a portion of the full costs of production. Once again, the problem is one of finding a balance between costs and benefits.

The opportunity to use economic mechanisms to signal scarcity and to coordinate more efficient resource use is quite limited. Because the Act is permissive, regional and local councils are able to persist with the planning approaches of an earlier era. It is therefore hardly surprising that very few economic instruments are in use.

Section 32 of the Act requires a clear understanding of both environmental issues and community priorities, and the end-states associated with the use of environmental assets. It is quite straightforward to express s.5 and s.32 as a constrained "optimisation problem" with the objective being defined in terms of social, economic and cultural well-being; the choice variables are the use-rates of environmental resources; and, the feasible set defined according to the needs of future generations and the protection of environmental assets. In practical terms, regional councils are required to consider whether or not regulatory interventions are necessary for achieving the goals implied by legislation. If action is necessary then the alternative means and instruments for achieving sustainability must be considered, including an assessment of the benefits and costs. Section 32 makes the link between effects and alternative means explicit. In particular:

32. Duties to consider alternatives, assess benefits and costs, etc.- (1) In achieving the purpose of this Act, before adopting an objective, policy, rule, ..., any person shall-

(a) Have regard to-

- (i) The extent (if any) to which any such objective policy, rule or other method is necessary in achieving the purpose of the Act; and
- (ii) Other means ... which under this Act or any other enactment, may be used in achieving the purpose of this Act, including the provision of information, services, or incentives and the levying of charges (including rates); and

(iii) The reasons for and against adopting the proposed policy objective, policy rule, or other method and the principal means available, or taking no action where this Act does not require otherwise; and

(a) Carry out an evaluation, which that person is satisfied is appropriate to the circumstances, of the likely benefits and costs of the principal alternative means including, in the case of any rule or other method, the extent to which it is likely to be effective in achieving the objective or policy and the likely implementation and compliance costs; and

(b) Be satisfied that any such objective, policy, rule, or other method ...

(i) Is necessary in achieving the purpose of this Act;

and

(ii) Is the most appropriate means of exercising the function, having regard to its efficiency and effectiveness relative to other means.

(2) Subsection (1) applies to -

(a) The Minister, in relation to ...

(b) The Minister of Conservation, in relation to ...

(c) Every local authority, in relation to the setting of ...

(3) No person shall challenge any objective, policy, or rule in any plan or proposed plan on the grounds of subsection (1) has not been complied with, except-

(a) In a submission made ... in respect of a proposed plan or change to a plan; or

(b) In an application or request to change a plan

The Act introduces for the first time a set of regulatory principles which are to be applied by Ministers and local authorities before they adopt objectives, policies, rules or methods under the Act. Specifically, administrators are required to have regard to the extent to which planning action is necessary to achieve the purposes of the Act and the alternatives available. Administrators are required to carry out an evaluation, appropriate to the circumstances, of the benefits and costs of the principal alternative means, having regard to efficiency and the effectiveness of alternative relative to other means. In summary, the principal objectives of s.32 are to ensure that:

1. there is a need to adopt a planning intervention,
2. alternative planning interventions are considered,
3. reasons for and against are explicitly considered,
4. costs and benefits are taken into account, and
5. the intervention adopted is efficient and effective.

Economic aspects of section 32

A comprehensive assessment is implied by s.32. The benefits and costs of alternatives should be assessed (not necessarily quantified), including monetary and non-monetary costs and benefits, implementation and compliance costs. In the context of the Act it is probably more accurate to describe economic instruments as market-like mechanisms because the Crown, through its agents, retain significant rights that have the effect of constraining the use of so-called market mechanisms. For example, the Act provides for transferable water permits. Prices could evolve out of a quasi-market arrangement that allows for the transfer of rights within the constraints of sustainability. But note that transfers will be limited by restraints - such as minimum instream flows - determined in non-market institutions.

Section 32 makes an explicit link between end-states in the environment and alternative means. In general terms, two steps are involved. First, if sustainable use (e.g. an end-state defined in terms of water quality) is an issue then it becomes a binding constraint or a so-called environmental "bottom line". Second, the specific instrument or means (e.g. levying a charge on waste discharges) used for attaining the sustainable outcome must be considered alongside other alternatives (e.g. regulations specifying limits to discharges). Although the Act sets some bounds on the range of mechanisms (e.g. water discharge permits are not transferable) it does not offer precise definitions, leaving Councils to consider the options. Councils must, however, be in a position to justify use of a specific mechanism for achieving the objectives of the Act in terms of its efficiency and effectiveness relative to other means.

First, let me deal with the notion of an effective planning action. Assuming a need for action, it would appear that one question being asked in s.32 is: does the action achieve the purpose of the Act? Naturally one would expect to see the so-called "do-nothing option" included in the set of feasible actions. If action is not necessary then administrators have no statutory basis for intervention. If action is necessary then administrators have a duty to consider the range of available means for achieving the purposes of the Act. In situations where action is necessary there will be at least 2 alternative means for effectively achieving the purpose of the Act. Linking planning

actions with environmental outcomes must necessarily involve an assessment *ex ante* of the probabilities of a particular action being effective. Effectiveness, it would appear, is a necessary but not sufficient test.

Let's now turn to the issue of efficiency. Section 32 imposes a duty on local authorities to evaluate the alternative courses of action in terms of likely benefits and costs, including implementation and compliance costs. The test of sufficiency is provided by an evaluation of the benefits and costs. Cost-benefit analysis (CBA) is one way of choosing among competing uses. It is:

An estimation and evaluation of the net benefits associated with alternatives for achieving defined public goals.

A state in which benefits exceed costs is judged to be good because it serves to guide public choice so that social well-being is enhanced.

Why do a CBA? The main reason is to subject environmental policy to a consistent test. Cost-benefit analysis is a framework for systematically organising and evaluating facts. It is a substitute for *ad hoc* decision making. In short, it provides a rational framework for choice. Although CBA seeks to describe and quantify all the social advantages and disadvantages of a policy it is not a prescription for action.

CBA is based on the criterion of economic efficiency. Benefits (B) are what people are willing-to-pay for the services of a good and costs (C) are measured in terms of opportunity cost. Where market (M) prices exist they can be used in the analysis, many services associated with the environment are not priced in the market and non-market (NM) valuation techniques may be used to estimate benefits and costs. In summary then, s.32 assessments will inevitably involve both market valuations and non-market valuations of benefits and costs:

$$B = \{ B_M, B_{NM} \}$$

$$C = \{ C_M, C_{NM} \}$$

Section 32 does not offer any guidance on the accounting stance to use in the analysis. It makes a difference as to how benefits and costs are incorporated into the assessment. A change to a regional plan may confer quite different costs and benefits to a region compared to the nation as a whole.

A simple maximisation model can be used to illustrate the assessment implied by s.32:

$$NB(q) = B(q) - C(q)$$

where

$NB(q)$ = net benefits associated with a planning action q

$B(q)$ = benefits

$C(q)$ = costs

Net benefit is maximized when

$$dNB(q)/dq = 0$$

$$\Rightarrow MB(q) = MC(q)$$

If we let $\{q\}$ represent the alternative planning actions available to a local authority then s.32 asks, in the name of efficiency, that q^* be selected. Obviously, I am not suggesting that local authorities undertake s.32 assessments to this level of detail.

Management Organisation

Property rights also structure incentives and opportunities within regional councils. Incentives guiding resource use and accountability for the outcomes associated with resource allocation decisions made within a bureaucracy are quite different from those in for-profit organisations. Behaviour depends on whether the individual (or group of individuals) face the opportunity costs associated with the exercise of the right. The power to exercise a right which imposes costs on others, without having to pay compensation, diminishes incentives to accurately reveal information on prices (opportunity costs).

Continuing with water as an example, the Act assigns the responsibility of water management to regional councils. A principal function of regional councils will be to produce water management plans which *inter alia* establish the quantity of water available for abstraction, seasonal reserves and instream uses. In other words, the water management plan establishes (sustainable) use-rates consistent with the purpose of the Act. The plan is to be derived from, and be consistent with, national and regional resource policy statements.

The Act distributes strands of the water allocation process to the private sector (e.g. transferable water permits) and to the political sector (regional councils). The judicial system is seen to fulfil its usual role in law. If transferable water permits are to perform their allocative function effectively then the opportunities for trade should be isolated (as much as practicable) from political interference. However, under the existing legislation barriers to trade will emerge because the water management planning process is located within a collective decision-making process which gives considerable discretionary power to regional councils.

Some groups will have to rely on the political sector for the provision of services (for example, instream interests) and for protection of their interests. Regional councils will, presumably, take these concerns into account during the formulation of their regional resource policy statements. Because adjustments to the bundle of property rights governing access and use are unavoidable it is important that the opportunity cost of changing rights is measured and incorporated into the decision making process. Transferable water permits will provide valuation information on the opportunity cost of water. However what costs will administrators face when a change to a water management plan reallocates water from out-of-stream users to instream use?

I have likened the Resource Management Act framework to a constrained optimisation problem. Councils have a duty under the Act to set sustainability constraints, the so-called environmental bottom lines. In a world of scarcity, changes to these constraints will, in all probability, influence the economic, social and cultural wellbeing of individuals and communities. To the economist, this sounds very much like a second-best world. Managing the use-conservation interface requires information on the impact of changes to the environmental bottom lines on social, economic, and cultural wellbeing.

Liability

Financial-legal instruments can operate in either an *ex ante* or *ex post* fashion. In principle the level of the financial compensation can be based on damages. Performance bonds are an *ex ante* payment to a council in expectation of compliance with imposed standards. The deposit is held until the council is satisfied that the standard has been achieved. If the conditions are not satisfied, then work required to achieve the standard can be financed (provided the bond is sufficiently large enough) out of the deposit. Section 108 of the Act empowers councils to require a bond to be given by a resource consent applicant to ensure the carrying out of conditions on the resource consent.

Non-compliance fees are imposed as an *ex post* payment (essentially a fine) when polluters do not comply with regulations. Sections 338 and 339 provide for offences against the Act and penalties for offences. An alternative to establishing penalties in statute is to base the fee/fine on profits made through non-compliance, or the cost of restoring the environmental functions and benefits lost as a result of non-compliance. The latter approach confronts users with an opportunity cost measured in terms of environmental damage.

Recent case law

Foodstuffs v Dunedin City Council 1993 arose from a plan change to the Dunedin City transitional district plan which was to rezone a central city block, a change that would have allowed large-scale vehicle-orientated retail outlets as permitted activities. The plan change was in keeping with a project to build a Big Fresh supermarket. The proposed plan change was prepared and submitted by the applicants to Dunedin City Council. After public consultation, a public hearing and subsequent revisions arising out of deficiencies revealed by s.32 analysis, the Planning Hearings committee of the Dunedin City Council approved the plan change. The plan change was opposed by, among others, Foodstuffs, Countdown and Russell Nieper Ltd (the referrers).

The following submissions allege that the respondent had failed to perform its duties under s.32:

1. the respondent had not disclosed the content of the analysis so that parties had an opportunity to make submissions on it,
2. the respondent had not attended to s.32 duties at the time required,
3. the substance of the purported analysis was deficient.

The Planning Tribunal *inter alia* held:

1. The use of the term "proposed plan" in s.32(3) did not preclude a challenge to the respondent's performance of its s.32 duties in a submission under cl 6 of the First Schedule. Privately requested plan changes are exempted from the limiting effect of s.32(3), and therefore the referrers are entitled to be heard on their submissions about the respondent's alleged failures to comply with s.32(1).
2. The respondent had not failed in its duties under s.32 because of the timing of its s.32 analysis. The respondent had adopted the objectives, policies and rules of Plan Change 6 once having heard and deliberated on the submissions received. It is, however, interesting to note that the committee's report fell short in the area of transparency - it had to be inferred that the respondent was satisfied that the objectives, policies and rules were necessary in achieving the statutory purpose as required by s.32.
3. The submission that the respondent had failed its s.32 duties by not disclosing the content of its analysis so that parties had an opportunity to make submissions on it was rejected. The report summarising the s.32 analysis was part of the committee's internal decision making and did not involve the introduction of new material that should have been disclosed.
4. With respect to the respondent's s.32 analysis the Tribunal noted s.32(1)(b) qualifies the extent of the evaluation required, i.e. it should be appropriate to the circumstances. It is interesting to note that the Tribunal considered that the

".. sufficiency of the evaluation in the circumstances is to be judged by the decision maker. That would not preclude a Court finding ..." p.520.

The Tribunal acknowledged that a more sophisticated analysis was possible and noted that the respondent was evidently content to carry out a relatively simple process. In my opinion, the level of sophistication necessary to satisfy a duty under s.32 should not rest solely with the local authority; surely the level and detail of analysis should be contestable.

CONCLUSIONS

The 1987 reforms to environmental organisations were significant and, by world standards, quite innovative. Setting aside the technical difficulties of evaluating the benefits of institutional change, have the reforms produced positive sum gains? Clearly, separating out commercially viable activities into SOEs and LATEs has improved transparency and accountability. I would go further and suggest that efficiency gains have been achieved. Further reforms at the margin, especially in the area of resource pricing would produce additional efficiency gains.

The benefits of the Resource Management Act are less clear. It was aimed at consolidating a complex array of overlapping, and often conflicting, legislation administered by numerous agents of the Crown. This consolidation and rationalisation has been achieved. Furthermore the Act devolved many strands of the rights and

duties of decision making away from central government to local units of government, and to individuals, groups and firms. But this devolution is likely to be the source of future inefficiencies.

First, if the environmental objectives, policies and rules necessary for achieving the purpose of the Resource Management Act 1991, are to be guided by benefit and cost assessments then these assessments should become an integral part of the decision making process. It would appear, from the evidence I have read, that s.32 assessments run the risk of not being the object of critical open debate. It is the framework of CBA that provides the discipline for rational decision making; better decisions will result from assessments that are appropriate to the situation and open to public scrutiny and submission. So far I have seen little evidence of good s.32 analysis. It is wise to separate the function of s.32 assessment from the act of adopting a regulatory intervention. That is, s.32 assessments should logically occur prior to the act of decision making.

Second, the ability to challenge decisions on the grounds of non-compliance with s.32 is likely to enlarge the issues before the Planning Tribunal. However, it is too early to determine how far the Tribunal is willing to debate and rule upon alternative means and their relative effectiveness and efficiency. To date, as evidenced by *Foodstuffs v Dunedin City*, it would appear that the Tribunal will focus primarily on statutory procedure. This is consistent with the Planning Tribunal's reluctance to involve itself with policy decisions.

Third, administrators of the Act have been slow to recognise the fundamental change to resource management legislation viz the focus on effects and the increased scope for using economic instruments. To date, the potential of economic instruments is far from being realised. In part this is due to permissive legislation, but it is also due to a lack of understanding of their potential role in resource management. They are more flexible and, in many situations, a more efficient alternative to centralised planning based on regulations. Councils appear to be content with using their customary instruments viz regulations. The Ministry for the Environment should take undertake a critical examination of the instruments used, it might well be necessary to change the legislation before efficiency gains can be achieved.

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Agricultural Restructuring Effects: an Industry Perspective

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1. Introduction

For many years agriculture has been seen as the major sector of the New Zealand economy upon which all other sectors depended, and upon which New Zealand was dependent for economic growth. During the last decade, particularly the mid 1980's, this proposition has been questioned by various commentators and policy makers. It is therefore useful to review the situation for New Zealand agriculture, to assess the trends in the importance of the sector for New Zealand and to look forward to what the future might hold for the sector and for the New Zealand economy, in relation to the role of agriculture within that economy.

This paper provides an analysis of some of the indicators that are important for the agricultural sector and looks at the relationship between the sector and the New Zealand economy as a whole. The time period over which this brief analysis is provided commences at a point shortly after the major restructuring of the agricultural sector had begun and when the NZ economy was also commencing the transition to a "more market" situation.

Prior to this period, NZ economic activity had become more and more entrenched in a close relationship with the NZ Government through a process of control by Regulation. As a result of the controls placed on almost all sectors of the economy and a consequent exchange rate relationship which was considered by most commentators to reflect a major over-valuation, the export sectors, particularly agriculture, had become less and less competitive. To offset this, substantial subsidies were paid to the export sector with agriculture being a major recipient. By the mid 1980's it was clear that the level of subsidy could not be sustained and major changes were inevitable. These changes were put in place by the new Labour Party Government which was elected in 1984.

The removal of subsidies had a dramatic impact on the agricultural sector. Some of the effects of the changes are discussed in the next Section of this paper. Section Three of the paper looks at the relationship between the agricultural sector and the NZ economy as a whole while Section Four provides some speculation on the longer term future.

2. From 1987 to 1992

The major impacts of the restructuring in the agricultural sector have been in three areas. One is the decline in the "value" of farmland, which was a direct result of the removal of subsidies. The second has been the decline in the total number of stock units carried on New Zealand farms as a result of the retirement of land brought into use under the influence of subsidies (and the decline in the number of stock on farms as a result of a lower level of farming inputs (capital and labour)). The third is the redistribution of stock numbers with sheep numbers declining and cattle (including dairy), deer and goat numbers growing.

The most dramatic change was in the number of sheep with a peak in 1981 of 69.884 million being reduced to 51.2 million in 1993 (provisional), a fall of 18.7 million or 27 per cent (Table 1).

Table 1
Livestock Numbers : 1972 to 1992

	Dairy	Sheep	Beef	Deer	Goats
1972	3.289	60.883	5.344	-	-
1975	2.998	55.320	6.294	-	-
1978	2.991	62.163	5.507	-	-
1981	3.134	69.884	5.113	0.109	0.068
1984	3.246	69.739	4.531	0.258	0.230
1987	3.195	64.244	4.804	0.500	1.054
1990	3.464	57.852	4.601	0.976	1.062
1991	3.429	55.162	4.671	1.129	0.792
1992	3.469	52.571	4.676	1.135	0.533
1993 _p	3.550	51.200	4.880	1.040	0.520

_p Provisional

Source: Fairweather, 1992; MAF, 1994

At the same time as the change in stock numbers has been occurring, there has been a decline in the number of sheep and beef farms and cropping farms and an increase in the number of dairy farms, horticultural farms and "other animal" farms (mostly deer) (Fairweather, 1992).

Table 2 provides information on the movement in farmland values which occurred over the period of high farming subsidisation and the period following the removal of the subsidies. This indicates a real growth in farmland values of 40 per cent by December 1982 followed by a decline to take real farmland values 25 per cent below the June 1980 level by December 1988. Values had recovered through to December 1992 to be equivalent to the June 1980 value.

Table 2

Farmland Price Index (Base Dec 1989 = 1000)
and Turnover Rate

Half Year Ended	Farmland Price Index	Per Cent Change		Turnover Rate (%)	Deflated Index	Change in Real Terms (Cum)
		Per Period	Cumulative			
June 1980	463	-	-	2.0	463	-
Dec 1980	505	+9.1	+9.1	2.0	470	+1.5
June 1981	604	+19.6	+30.5	2.1	525	+13.4
Dec 1981	708	+17.3	+52.9	2.1	571	+23.3
June 1982	846	+19.4	+82.7	2.3	629	+35.9
Dec 1982	932	+10.2	+101.3	2.0	651	+40.6
June 1983	920	-1.2	+98.7	1.5	631	+36.3
Dec 1983	928	+0.8	+100.4	1.9	626	+35.2
June 1984	964	+3.9	+108.2	1.8	632	+36.5
Dec 1984	969	+0.5	+109.3	1.7	597	+28.9
Dec 1985	967	-0.2	+108.9	1.5	517	+11.7
Dec 1986	933	-3.5	+101.5	1.2	422	-8.9
Dec 1987	921	-1.3	+98.9	1.5	380	-17.9
Dec 1988	882	-4.2	+90.5	1.8	348	-24.8
Dec 1989	1000	+13.4	+116.0	2.5	368	-20.5
Dec 1990	1188	+18.8	+156.6	2.3	416	-10.2
Dec 1991	1181	-0.6	+155.1	na	410	-11.4
Dec 1992	1358	+15.0	+193.3	na	465	+0.4

Employment numbers have also shown significant movements as a result of the agricultural restructuring. MAF (1993) analyzed the change in employment numbers for a range of industry sectors and the relevant statistics are given in Table 3. These statistics indicate that there has been a major decline in full time (F/T) employment in farming with most of the decline occurring in

sheep farming (down by 43 per cent from 1981) and some decline in dairy farming F/T employment. This has been partially offset by an increase in F/T employment in beef farming and fruit growing. Also of significance is the increase in part time (P/T) employment on farms apart from sheep farms.

In the off-farm sector, the impact of restructuring can also be seen in the employment numbers for the sectors which depend on agriculture for their raw material inputs. The slaughtering and meat processing sector F/T employment fell by 39 per cent from 1981 to 1991 and P/T employment in this sector also fell between 1986 and 1991. The fall in employment levels in this sector was such that major gains in labour efficiency were achieved with a much higher level of output being achieved per employee.

Dairy product manufacturing also exhibited considerable gains in labour efficiency as a higher level of throughput was handled by fewer employees. This was a result of the closure of some smaller dairy manufacturing companies and the handling of the milk through larger more capital intensive plants.

The "food, beverage and tobacco" and "textiles, clothing and leather" sectors also exhibited declines in the number of employees. This was particularly marked in the latter sector where the decline from 1981 to 1991 in F/T employees was 45 per cent. This was a result of the removal of protection for the local textile industry as part of the liberalisation / restructuring process.

At the same time as the level of F/T employment was declining, there was a significant increase in the number of people employed on a P/T basis with approximately twice as many people employed part time in 1991 as in 1981. In the farming sector, the growth in part time employment numbers was by a factor of three.

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Table 3
Employment Statistics

		1981	1986	1991
Dairy Farming	F/T	32,709	31,120	26,865
	P/T	na	4,218	4,752
Sheep Farming	F/T	43,773	36,387	24,612
	P/T	na	4,812	3,876
Beef Farming	F/T	3,690	5,898	5,451
	P/T	na	1,128	1,437
Fruit Growing	F/T	10,431	13,764	12,096
	P/T	na	3,606	2,958
All Farming ¹	F/T	130,212	123,783	108,771
	P/T	8,247	21,813	23,265
Slaughtering & Meat Processing	F/T	38,853	29,739	23,628
	P/T	na	7,857	3,333
Dairy Product Manufacturing	F/T	9,966	8,385	6,945
	P/T	na	282	291
Food Beverage & Tobacco ¹	F/T	76,779	63,543	53,235
	P/T	1,791	11,148	6,882
Textiles, Clothing & Leather	F/T	45,546	40,068	25,269
	P/T	1,782	4,794	3,525
Total NZ Workforce ¹	F/T	1,332,342	1,278,204	1,151,196
	P/T	115,137	221,217	249,204
	Total	1,447,479	1,499,421	1,400,400

¹ Includes other categories not listed

Source: New Zealand Population Census, Department of Statistics (1991)

Other major changes that took place between the mid 1980s and the early 1990s were the decline in capital expenditure on farms and the changes in fertiliser application that took place as a result of the decline in farm sector incomes.

Farm building permits issued declined from in excess of seven thousand in 1984 to less than three thousand in 1991 (MAF, 1993). Annual investment in farm plant and machinery fell from over \$200 million in the mid 1980s to less than \$100 million in 1988. Some recovery has occurred since then.

Total manufactured fertiliser sales peaked in 1984-85 at slightly over two million tonnes (MAF, 1993) and then fell to only slightly over one million tonnes in 1986-87 before recovering to 1.3 million tonnes in 1989-90 and fluctuating since then but with expected growth to around 1.7 million tonnes in 1993-94. However, sales of "Other Fertiliser Materials" have been growing steadily since 1987-88 and are expected to have reached 0.6 million tonnes in 1993-94 (MAF, 1994).

The cause of the above fluctuations in input levels has been the variation in "farm profit before tax". For sheep and beef farms, a low point was reached in 1985-86 with farm profit before tax declining by more than 50 per cent (in real terms) from the 1984-85 level (Sheppard and Lattimore, 1993). Some recovery was recorded in 1986-87 with stability over the next three years and some improvement in the 1989-90 year. In real terms (\$1988) farm profit before tax (sheep and beef farms) declined from \$63,967 in 1975-76 to \$20,813 in 1985-86 and has since risen to an estimated \$33,500 in 1993-94. This represents a level 47 per cent lower than the 1975-76 farm profit before tax and is 37 per cent lower than in 1984-85 and clearly demonstrates the shift that has occurred in sheep and beef farm profitability.

3. Relationship to the New Zealand Economy

There are a number of ways in which the relationship between the agricultural sector and the rest of the economy can be measured. There is no doubt that agriculture remains an important part of the economy and there is equally no doubt that it will remain as a major contributor to the economic well-being of New Zealand.

3.1 Contribution to Exports

The agricultural sector is often seen as the basis of New Zealand's export trade. Examination of the trade statistics tends to confirm this impression (Table 4). Although agricultural based exports are declining as a proportion of the total exports of New Zealand goods, the proportion is still over 50 per cent. Within the agricultural sector, the contribution from "other" exports has been growing reflecting increased diversification of export forms.

Table 4
New Zealand's Agricultural Exports
(\$million FOB)

	1988	1989	1990	1991	1992	1993
Meat and meat products	2217.2	2424.9	2335.1	2612.1	3031.9	3087.6
Dairy Products	1776.4	2234.1	2534.2	2485.0	2897.1	3369.0
Wool	1727.9	1909.0	1424.1	1043.7	1172.7	984.7
Fruit and Vegetables	834.2	824.2	998.6	1069.4	1166.6	1026.3
Hides, skins, leather	714.6	747.1	675.9	583.0	581.9	615.3
Other	343.7	864.0	816.2	958.3	1142.7	1183.7
Total Agricultural Based Exports	7614.0	9003.3	8784.1	8751.5	9992.9	10266.6
Total NZ Exports of Goods	12104.1	14905.4	15163.5	15768.4	17890.6	19006.2
Agricultural Based as % of Total Exports of Goods	62.9	60.4	57.9	55.5	55.9	54.0

Source: MAF, 1993 & 1994

3.2 Contribution to Gross Domestic Product (GDP)

The agricultural sector contribution to GDP was nearly 14 per cent of GDP in 1992 and in 1993, the contribution was provisionally given at a little over 14 per cent (Table 5). This contribution has declined over the last ten years from nearly 17 per cent of the total in 1982 as the absolute level of New Zealand GDP has grown more rapidly than has the agricultural sector, i.e. New Zealand GDP has grown by 163 per cent (in money terms) over the ten year period while agricultural sector GDP has grown by only 120 per cent. The main "contributor" to the decline has been the fall in proportionate GDP contribution from the farming part of the sector which has declined from 8.0 per cent of GDP in 1982 to 5.8 per cent of GDP in 1993. This fall has been matched by the decline in importance of the input supply sector which has fallen from 2.1 per cent of GDP to 1.5

per cent. The processing and wholesale/retail sectors have maintained their relative positions while the transport sector shows a decline.

The growth in the agriculturally based processing sector by 193 per cent over the period while the farming sector has only grown by 96 per cent indicates the growth in importance of agricultural sector processing as products have become more market orientated. Another way of looking at this is to observe that for every dollar of farming output in 1982, another \$0.61 was produced in the processing sector. By 1993, for every dollar of farming output another \$0.91 was produced in the processing sector. The contribution of the processing sector was in fact larger than the contribution from farming in both 1991 and 1992.

Table 5
Agricultural Sector Contribution to GDP

Year ended March								
	1982		1987		1992		1993 _p	
	\$b	% of GDP	\$b	% of GDP	\$b	% of GDP	\$b	% of GDP
Farming	2.3	8.0	3.0	5.6	4.2	5.7	4.5	5.8
Processing	1.4	4.8	2.4	4.4	3.6	4.9	4.1	5.3
Input Supply	0.6	2.1	0.9	1.7	1.1	1.5	1.2	1.5
Wholesale/retail	0.4	1.4	0.7	1.3	1.0	1.3	1.0	1.3
Transport	0.2	0.7	0.2	0.4	0.3	0.4	0.3	0.4
Total Agriculture	5.0	17.0	7.3	13.4	10.2	13.8	11.0	14.3
Total New Zealand	29.3		54.5		73.4		77.1	

_p Provisional . Estimate

Source: MAF, 1993 & 1994

3.3 Contribution to Employment

Table 6 provides information on the contribution of the agricultural sector to employment in New Zealand. The data has been presented in full time equivalents and therefore cannot be directly compared with the data presented in Table 3. Of particular interest from Table 6 is the decline in the proportion of the total workforce involved in the agricultural sector from 20.3 per cent in 1982 to 18.1 per cent in 1993, the decline in the processing sector from 7.1 per cent to 4.9 per cent and the relative stability of the proportion in farming at around nine per cent. The decline in the

proportion involved in processing is particularly significant given the growth in the contribution to GDP from that sector (see Table 5) implying that there has been a major labour productivity growth in the processing sector. This is clearly a reflection of the improvement in labour productivity achieved by the meat processing sector over the period (Sheppard, 1993).

Table 6
Agricultural Sector Contribution to Employment

Year ended March								
	1982		1987		1992		1993 _p	
	(000)	% Work Force	(000)	% Work Force	(000)	% Work Force	(000)	% Work Force
Farming	118.9	9.2	109.6	8.2	129.3	10.1	124.3	9.5
Processing	91.9	7.1	79.9	6.0	62.2	4.9	63.5	4.9
Input Supply	31.1	2.4	27.1	2.0	21.4	1.7	21.8	1.7
Wholesale/retail	12.4	1.0	10.8	0.8	14.0	1.1	15.1	1.2
Transport	9.7	0.7	5.5	0.4	11.0	0.9	11.9	0.9
Total Agriculture	262.5	20.3	232.9	17.4	237.8	18.6	236.7	18.1
Total NZ	1,290.9		1,388.8		1,280.1		1,308.4	

_p Provisional

Source: MAF, 1992, 1993 and 1994

From Tables 5 and 6 an estimate can be made of the contribution to GDP by each of the agricultural sub sectors on a per full time equivalent person basis. This analysis can contribute to an understanding of the relative importance of each sub sector and the changes that have been occurring within the agricultural sector. Table 7 provides information on the level of GDP contribution per person employed in the various agricultural sub sectors.

Table 7
GDP Contribution per Full Time Equivalent Person
(\$'000)/person)

	Year ended March							
	1982		1987		1992		1993	
	\$(000)/ Person	% of Ag	\$(000)/ Person	% of Ag	\$(000)/ Person	% of Ag	\$(000)/ Person	% of Ag
Farming	19.3	102.1	27.5	87.8	32.2	75.4	35.9	77.0
Processing	15.3	81.0	29.9	95.5	58.0	135.8	63.8	136.9
Input Supply	19.9	105.3	33.8	108.0	52.5	123.0	53.2	114.2
Wholesale/ retail	37.7	199.5	63.5	202.9	69.3	162.3	68.0	145.9
Transport	21.0	111.1	44.3	141.5	27.6	64.6	26.8	57.5
Total Agriculture	18.9		31.3		42.7		46.6	
Total NZ	22.7		40.7		57.3		58.9	
Agriculture as % of Total		88.3		76.9		74.5		79.1

From Table 7 it can be observed that the average amount of GDP supplied per person working in the economy is significantly greater than that supplied by the people working on the farm (\$36,000 cf. \$59,000 in 1993). Also, the proportion of the GDP per person involved in farming has been declining in comparison to the GDP supplied per person off-farm (the farming contribution was 102.1 per cent of that for total agriculture in 1982 and 77.0 per cent in 1993). The growth in the GDP generated per person employed in the processing sector is particularly significant. It can also be observed that the GDP per person working in the agricultural sector is declining as a proportion of the GDP generated per person working in the rest of the economy (88.3 per cent in 1982 compared with 74.1 per cent in 1992 but rising to 79.1 per cent in 1993).

The information presented in Tables 5, 6 and 7 indicates a decline in the relative return to the labour employed in the farming sub sector and a decline in the importance of the agricultural sector as a whole, with respect to the rest of the economy. However, in spite of the decline, the agricultural sector still contributes over 50 per cent of New Zealand's exports and represents about 14 per cent of GDP and employs approximately 18 per cent of the workforce. A decline in the importance of the sector relative to other sectors is an indication of the broadening of the economic base in New Zealand and perhaps the growth of a more stable economy which may not be affected as significantly as in the past by fluctuations in the agricultural economy.

4. Where Does Agriculture Go From Here?

New Zealand has moved a considerable distance from the days of early development (late 1800s) and outright dependence upon the agricultural sector. The process of developing alternative activities has proceeded at a variable pace depending upon the external market environment and internal policies involving import replacement encouragement and subsidies for agriculture. At the present time, the policy stance is in favour of a "cleaner" relationship between the internal New Zealand market and that provided by overseas suppliers and importers. This has resulted in the decline in internal assistance to import replacement industries and a decline in support for export oriented sectors. The outcome of this has been the development of a stronger export sector as a wider range of companies and industries has become involved in the export sector through the realisation that export opportunities are available for non agricultural products and that, at current exchange rates, NZ manufacturers are able to supply products at competitive prices. The removal of export sector support in the form of subsidies for producers and export incentives for actual exporters has resulted in improved competitive ability in New Zealand based mainly on gains in productivity.

The outcome of this has been the decline in the agricultural sector as a proportion of export earnings, as a proportion of GDP and as a contributor to employment.

What is the future?

The long term outlook for agricultural producers in all countries is a declining importance within the world economy. As food products become more "sophisticated", involving more complex processing and packaging, the off-farm agricultural sector will grow in importance. This has been observed over the history of New Zealand and can be expected to continue.

In addition to the decline in the importance of production within the agricultural sector, a decline in the importance of the sector as a whole can also be expected. As incomes increase in a world wide sense, the proportion of that income that will be spent on food items will decrease. More disposable income will be spent on other consumables and in particular the "service sector" can be expected to continue to grow both absolutely and as a proportion of total economic activity.

The goal for those involved in agriculture must therefore be the continuous development of more efficient means of production and processing both in terms of the output able to be achieved per land and labour unit and the efficient use of capital. Technological development must be seen as the means by which agriculture will progress in the future and such progress should be measured in terms of reductions in the amount of inputs required to achieve specified outputs. At the same time, the sector will need to concentrate on producing those products which are in demand and in developing a flexibility to respond to changes in demand. This will involve the further expansion of the off-farm sector as a proportion of the total agricultural sector with the expansion being achieved in ways which reflect increasing productivity and responsiveness to demand movements.

From a longer term point of view, it is my opinion that the present rigidity in the farm production system which is exemplified by the current growth in beef production while markets are declining, will have to be addressed by producers, processors and marketers. The decision to produce either sheep meat or beef will have to be replaced by a decision to produce "what level of meat protein?". Under this scenario, the way in which the protein is produced will depend upon the most economical/efficient production system whether it be via the use of sheep, cattle, pigs, poultry, etc. In other words, the demand in world markets will be (and currently is) for meat protein. The sources of that protein are substitutable between the different animals. Within a short time (a decade or two) the source animal will not be important. Meat protein will be seen as an industrial material input (as is milk protein at present) and farmers will make decisions about the level of protein they will produce and then concentrate on the most economical way of producing it. This will mean that the farm sector will become more responsive to market demand, in terms of supplying the amount of protein required in the most cost efficient way, and the off-farm processing sector will handle the meat protein input as a raw material from which it produces desirable protein based food.

In addition to this form of production system, opportunities will continue to exist for small niche market products at a high cost and price with specialist marketing and branding systems. The successful development of such products and markets will require tight product control from production through to the final consumer and therefore implies the need for the development of a vertically integrated industry. This could involve ownership of production systems by product marketers and processors or ownership of processing and marketing systems by producers. Alternatively, strong contract arrangements will be required between processors and marketers and their producers. From an international point of view, historical development implies that the control of the system will rest with the marketers and processors with contracts being formed with the producers in order to achieve the required level and quality of supply. This does not imply that the producers are necessarily disadvantaged in such a system as the business of the processors and marketers depends upon the product supplied by the producers and the quality and reliability of that supply. The whole system becomes interdependent and must be seen in this way, rather than as a confrontational process.

In summary, the NZ agricultural sector can be expected to continue to decline in importance relative to the rest of the economy. This will be a result of the growth of total disposable income within the economy and internationally and the growth in demand for non-agricultural products and services. The objective for the sector should be the continued development of new and existing technology in order to operate more efficiently and so attempt to maintain and improve returns to the resources involved in agricultural production, processing and marketing. The non farm part of the agricultural sector can be expected to continue to grow as a proportion of the agricultural sector as processing (including packaging) and marketing become more important components of agricultural products. Over time, agricultural production will need to focus on the consistent delivery of raw materials for processing and marketing with the form of production of undifferentiated material being decided according

to the most cost efficient production method. Vertical integration can be expected to continue through either ownership of factors of production or through the creation of binding supply contracts.

The future for the agricultural sector depends upon the continuous development of efficiency improvements in the production, processing and marketing processes. Such efficiency improvements can only be achieved through the continued investment in scientific research and development and the application of new technologies to the agricultural system process.

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**1984-94: Ten Years of Progress?
- An International Perspective**

by

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**1984-94: Ten Years of Progress?
- An International Perspective**

The reforms of the New Zealand economy in the decade 1984 to 1994 are receiving a lot of attention at the end of the decade and deservedly so. They are a rare experiment which should receive close attention by economics as a non-experimental science, in other countries as well as in New Zealand. My task is to view them from an international perspective, that is, to view them as an outsider. I am an outsider although I have maintained fairly frequent contact with New Zealand since my departure permanently in 1965.

I had one small input into the reform process. This was in the report by Lloyd and Others (1980) which was commissioned by the New Zealand Planning Council. The team of four consisted of myself and three others seconded from the Department of Trade and Industry, the Planning Council and the Treasury. At the time Muldoon was Prime Minister and there was little thought of radical reform of the New Zealand economy. However, it is interesting in retrospect to note that there was a growing dissatisfaction with the New Zealand economic performance by economists in New Zealand and increasingly bold suggestions were being made: see, for example, McLean (1978), Preston (1978), Carpinter (1979) and New Zealand Planning Council (1979). We nudged the process along a little bit, I hope. We noted in 1980 "The dismal record of almost stagnant real incomes, rising unemployment, wide fluctuations, and rising net emigration in the economy" (Lloyd and Others (1980, p. 52). We were strongly critical of the import licensing system, export subsidies and other distorting international trade policies, made a number of recommendations for the reduction of levels of border protection and increased structural adjustment. This advice was ignored by the government of the time but it has been far exceeded in the decade of reform that began in 1984.

1. The Pre-1984 Performance of the New Zealand Economy (Paradise Lost)

Prior to the 1984 reforms, the macroeconomic performance of the New Zealand economy was poor and deteriorating. Take the year 1984 as the pre-reform benchmark.

- the average monthly rate of unemployment was 4.9 per cent
- the rate of inflation was 4.3 per cent
- real incomes per capita was at the same level as a decade previously

- net immigration was positive again but small (6558) after being negative over the 6 years 1977 to 1982

(this is a most sensitive indicator of national economic welfare)

- the current account deficit was 8 per cent of the GDP

The statistics do not now seem so bad but they had been getting worse. The unemployment rate had been rising steadily since 1977. Inflation had been in the double digit band before controls on goods and factor prices were introduced by the Muldoon Government, and the current account was worsening.

One way of seeing the change over a long time is to fix on a single year. Let me take 1955. This is quite a good representative year as it is 3 years after the Korean War boom which severely shocked the New Zealand economy but the real reason I have chose it is because it is the year in which I enrolled in Stage I Economics at Victoria University!

By coincidence, the New Zealand Council of Educational research has conducted a longitudinal study of all students who enrolled in New Zealand Universities for the year 1955 (Livingstone (1980). I was one of the respondents. This survey showed that about 51 per cent of the male respondents and 46 per cent of the female respondents had studied or worked abroad at the time of the survey (1976-78). 15 per cent were still living abroad at the time of the survey and this is probably an underestimate.

In 1955 the number of unemployed (56) was exceeded by the number of notified vacancies (14,854) by a factor of 265. (Actually the statistic for the number of unemployed was a little hard to find since neither the Monthly Abstract of Statistics nor the Yearbook recorded the number of unemployed in those days!) And when I graduated some 5 years later I was able to take one of several jobs offered to me without may even searching the job market or lifting a finger. In that year too, my professor in Stage I Economics was Professor Horace Belshaw, one of New Zealand's most distinguished economists. I vividly recall him telling his Stage I class, proudly, that New Zealand ranked third in the UN league of per capita income, after only the United States and Canada. By 1984 it had fallen to 19th, sadly and tellingly. This reflects the fall in the rate of growth of real aggregate output and output per capita. This macroeconomic indicator is more important, I believe, than the rate of unemployment or the rate of inflation. I shall return to it later.

There was a tendency in New Zealand at the time to blame the deterioration in the performance on the large fall in the terms of trade which occurred in 1974 and 1975 but the deterioration was part of a definite long-term worsening in the New Zealand performance. A clear indication of this is the identification of two key turning points at which the macroeconomic series changed direction: post -War net immigration (permanent plus long-term movements) turned into net emigration in 1969 and 1970 (the net immigration from Australia alone had changed to net emigration in 1968), marking the end of a long period of sustained immigration; 1972 was the year in which the number of registered unemployed exceeded the number of registered vacancies for the first time in many years. This ended that phenomenon of post -War New Zealand, "overfull employment", which was quite remarkable and unique to New Zealand. The New Zealand economy had already undergone some basic structural changes by the early 1970s but it took a decade or so for the full extent of the troubles to be recognised by the bulk of the population.

Finally in this section, I want to draw attention to trends that had occurred in the world economy. The Seventies was another decade of uninterrupted growth in world trade and foreign investment. Multinational corporations had begun to globalise, source inputs from around the world and to locate plants in those countries which were the cheapest value adding location. Exchange rates were much more flexible. All of these trends exposed the New Zealand exporters and import-competing activities to greater international competition. It is these trends, together with the trade-restricting and regulatory policies of successive New Zealand governments, which brought about the crisis of 1984.

2. The Nature of the Reforms in the Decade 1984-1994

Immediately after its election in July 1984 and even before it had been sworn in, the new Labour Government began what was to be a wave of reforms of almost all areas of economic policymaking in New Zealand.

Several things can be said about these reforms as a set.

The reforms were sudden, swift in their execution and wideranging.

Some of them were very adventurous and innovative. In the field of trade policy reforms, I would mention tariffication which is a feature of the import liberalization programme adopted by New Zealand in 1984. This involved the tendering of import licenses, increases in the tender allocations of licenses and then the conversion of import licensing restrictions into tariffs when the observed tender premia fell to 7.5 per cent or less. New Zealand was

the first country in the world to my knowledge to "tariffy" (as it is now called) quantitative restrictions in this way. (I might also note that Australia had begun to tender part of its import quotas for passenger motor vehicles in 1980 and introduced a similar scheme for tendering part of the quotas for imports of clothing, textile and footwear products in 1982.) A second notable feature of trade policies also involves trans-Tasman cooperation, namely, the CER. (Although this agreement was reached in 1982 under the previous government, it has been substantially extended as a result of the 1988 and 1992 Reviews of the Agreement.) Of all of the regional trading arrangements in the GATT system, CER is the most transparent and "clean" (without complex rules, exceptions, derogations, safeguards, reviews and other complex rules).

The reforms were motivated by a desire to deregulate markets, reduce the size of the public sector and to give individuals a greater choice of goods on which to spend their incomes and freedom to work and invest as they choose. In short to free up the economy. This reversed the period of accumulation of greater regulatory powers which began with supposedly emergency measures introduced at the beginning of the war and continued long after this justification had disappeared. New Zealand had become by about 1950 the most regulated of all OECD countries.

But there is much more to these reforms than a liberal small government view of the management of the economy. The method of managing the macro-economy was changed profoundly. The best conception of this is to think of the Assignment Problem, the assignment of particular instruments of policy to particular macroeconomic policy objectives. Under the Reserve Bank Act 1964, the Reserve Bank was charged with advising the government on the monetary policy and monetary policy was to be directed to the pursuit of the government's macroeconomic objectives - general price stability, full employment, steady growth of production and levels of consumption, and external stability. This was changed in 1989 when the Reserve Bank Act was rewritten to make "achieving and maintaining stability in the general level of prices" the sole objective of monetary policy and to introduce the present system of a specific inflation target (currently 0-2 per cent per annum). The floating of the exchange rate left the exchange rate as the instrument to manage automatically what was called "external stability" by eliminating the excess demand for foreign exchange in the foreign exchange market.

Notwithstanding the sweeping coverage of the reforms carried out in New Zealand, there are some lacunae. I shall comment upon three.

The first is the maintenance of the statutory marketing authorities (Apple and Pear Marketing Board, Dairy Board, the Kiwifruit Marketing Board, Meat Board and Wool Board) with their monopoly trading powers. Going back to the report by Lloyd and Others, one feature I am particularly pleased with in 1994 is the brief comments we made on the statutory boards. We recommended (Lloyd and Others (1980, pp. 61-62)) that the monopoly powers of the boards should be reviewed. These statutory marketing boards are a part of the long New Zealand tradition of regulating trade, prices and production in major agricultural products but they have remained after almost all of the other controls and interventions have been removed. They are one of the few sacred cows in the New Zealand policy pantheon. I note that they have been vigorously attacked by the New Zealand Business Roundtable (see New Zealand Business Roundtable (1994, chapters 17 and 18)). (See also Crocombe, Enright, and Porter (1991, chapter 4)).

There is a very strong presumption that competitive private sector traders will outperform a government monopoly in any market and this presumption is much stronger in sales to highly diverse international markets. Competition among sellers will generate more variety of products and sales efforts and it will lead to the demise of the less efficient traders. There is nothing different about trading butter or cheese or apples to trading timber products or shirts or banking services. The New Zealand attitude that there is something special about agricultural commodities is the very attitude the New Zealand and Australian Governments have been attacking vigorously for many years in the GATT where it was used prior to the Uruguay Round to defend the exclusion of agricultural trade from multilateral trade liberalisation. (There is a need for study of the political economy of the primary industries. Why do a majority of the producers apparently favour their continuation?).

The second area is retirement policies. New Zealand still has a universal flat rate tax-funded pension which has been indexed since 1993 to average real wages and with weak individual based income test and no compulsory contributory superannuation. This combination provides strong incentives for the ageing to retire and to not save for retirement and hence to remain dependent upon government income support after retirement. This is a remarkable survival when other forms of income support have been reformed and personal income tax rates reduced.

The third policy area is capital gains tax. Admittedly the dramatic reduction in the rate of inflation has reduced the urgency of a capital gains tax but it remains a major omission in the personal income taxation system since the economic definition of household income includes (net) income due to the increase in the prices of assets traded by households.

3. Some International Comparisons

One feature that needs some emphasis is that New Zealand is not alone in carrying out radical reforms of the economy, as some New Zealanders seem to think. Indeed, there has been a wave of broadly similar reforms in many countries in the 1984-1994 period.

Australia has been carrying out reforms in almost all of the areas but over a longer period and more slowly. As in New Zealand, the major reforms were begun by a newly-elected Labour Government - in 1983. They began with the financial sector. In the international trade sector, the Australia dollar was floated in December 1983, 16 months before the floating of the New Zealand dollar, and following the 1973 across-the-board tariff cut it introduced major reduction in tariff and non-tariff border protection in 1988 and 1991 which have broadly kept pace with the reductions in New Zealand. It has lowered income tax rates and reformed substantially the welfare system and carried out microeconomic reforms. It introduced compulsory superannuation in 1990 but it has made much slower progress on the labour market front which is the Australian sacred cow.

Several other countries have carried out economic reforms in the 1980 and 1990s which have been radical and rapid (see, for example, the World Bank series of studies of reforms in the international trade sectors of many countries in Papageorgiou, Michael, and Choksi (1991)). These include Chile, Mexico, Indonesia, Malaysia, Thailand, India and Sri Lanka as well as New Zealand. The pace of reform is accelerating in South Asia and Latin America which have resisted change in the past. (Nor should we forget an earlier group of countries, the Asian NICs which carried out sweeping reforms in their economies in the 1960s and 1970s. The Chile-New Zealand-... wave is a short term wave in a Kondratieff cycle of reforms, as it were.)

Some of them have been as sweeping and as rapid as New Zealand's reforms; for example, those in Chile and India. Chile is a pioneer of rapid radical reform. Its reforms began in 1974. Like New Zealand, the Chilean reforms began with a change of government (though in Chile's case it was a violent military overthrow of the Allende government) after a long period of stagnation and currency and financial market crisis. The public sector deficit had risen to 25 per cent of the GDP. The Chilean experience is reviewed in a recent book by the Brookings Institution (Bosworth, Dornbusch, and Laban (1994)).

Another example is India. There are many parallels between the experiences of New Zealand and India. After a slow and hesitant start to reforms in the mid-1980s the Indian reforms began with a rush in 1991. They were precipitated by a balance of payments/

financial crisis and public sector deficit which rose to 8.4 per cent of the GDP in 1990/91. The government began with a 20 per cent devaluation of the Indian rupee in July 1991 and floated the exchange rate in 1993. There were a range of reforms to the trade regime (including the abolition of import licensing for non-consumer goods), foreign investment, regulation of industries, public sector enterprises, the tax system and other economic policies. (See East Asian Analytical Unit (1994, chapter 5) and Bhagwati and Srinivasan (1993) for an account of the events and discussion). The reforms were led by a dynamic Minister of Finance, Manmohan Singh, who, like Paul Keating and Roger Douglas before him, won the Minister of Finance of the Year Award - in 1993.

A feature of these countries is that all of the examples of radical and rapid reforms comparable to New Zealand are in the Third World. (I leave out the former Soviet bloc countries which have special problems due to the compounding of radical economic reforms with the transition to market economies and the break up of the Soviet Empire). This is not surprising since the New Zealand economy shared many of the structural characteristics and economic policies of developing countries. There is a definite pattern to the onset and the sequence of reforms in many of these countries.

4. The Performance of the New Zealand Economy since the Reforms (Paradise Regained?)

Have the reforms improved the performance of the New Zealand economy? One would certainly hope so. And it has, albeit much more slowly than its architects and the New Zealand population wished.

The public sector deficit and the current account deficit fell sharply. These were largely due to the reduction in public sector spending and aggregate demand.

The rate of inflation, as measured by the changes in the CPI, came down sharply in 1983, though it rose again to around 15 per cent in the mid-Eighties. Since monetary policy has been targeted at the rate of inflation, New Zealand has had one of the lowest rates of inflation in the OECD countries. For the latest period available of the year-on-year figures, ending in the March quarter 1994, the annual rate of inflation was only 1.3 per cent (Statistics New Zealand (1994, Table 6.03)).

The supply side of the economy responds more slowly. Unemployment continued to rise, especially after 1987 and peaked at 11.1 per cent in March 1992. The rise in unemployment was itself partly the result of the reforms, particularly the improvements in efficiency of the public sector, but it exhibits the typical "shock-plateau-shock" pattern which has been

characteristic of many OECD countries. According to Silverstone and Daldy (1993), the New Zealand labour markets have been subject to three unemployment shocks since 1984 - 1987, 1990 and 1992. The first two were unfavourable and were, in their view, due to reallocation of labour following government restructuring, deregulation and liberalisation. The latest figures available to me show that by the December quarter 1993 the unemployment rate had fallen to 9.2 per cent (Statistics New Zealand (1994, p. 29)).

Net immigration was negative from 1985 to 1990 but it has been positive, though small, in the four years since then. After two and a half decades of oscillation between net immigration and net emigration, New Zealand may be becoming once more a consistent immigrant country.

The series I want to concentrate upon is the GDP per capita and its annual rate of change. In my view this series is much more important than the rate of inflation or even the rate of unemployment. (See below.) The growth performance of New Zealand in the decade 1984 to 1994 has been disappointing. Real GDP crept upwards in the 1980s and only started to increase at a higher rate (seasonally adjusted) in the March 1992 quarter. As at March 1993, the index of the GDP at constant prices (seasonally adjusted) was 113.8. (Statistics New Zealand (1994, Table 10.07). This index has a base of 100 in 1982-83. Hence, real GDP has increased by 13.8 per cent over the decade, 1983-93. Since population increased at an average of around 3/4 of 1 per cent per year or around 8 per cent for the decade, this means that the rate of increase of national output per capita is less than 1/2 per cent. In 1993, the rate of increase accelerated sharply to 5.1 for the December quarter 1993 on December 1992 but it is far too soon to know if this heralds a new era of more rapid growth.

Overall the performance of the economy in response to these radical changes in policy must be regarded as disappointing in terms of the unemployment rate and the rate of growth of output. (I would like to add, however, that the series of the rate of growth of output may substantially understate the rate of growth of real incomes as it takes no account of the beneficial effect of removing the rationing of import goods under import licensing and some other similar controls such as rationing of foreign exchange for travel and of credit which have the effect of limiting the availability of goods and services. Any one who lived in New Zealand in the days when the waiting list for a car was years [unless you had a No Remittance license or some other fiddle] and you could only get \$200 for a trip overseas will understand the strength of this factor.)

I want to make some comparisons with other countries. There is no standard way of assessing the overall performance of economies. There are some useful measures such as the misery index based on the rates of inflation and unemployment. I prefer a graphical device used by the Asian Development Bank to summarise the macroeconomic performance of its member countries. This captures four indicators - GDP growth, the budget balance as a percentage of the GDP, the current account balance from the balance of payments as a percentage of the GDP, and the annual inflation rate. (See Asian Development Bank (1993, p.9). Note that three of these (the budget balance as a percentage of the GDP, the current account balance from the balance of payments as a percentage of the GDP, and the annual inflation rate) enter with the origin displaced. This gives a diamond shape. The larger the area within the diamond the better the overall performance. Let us call this the performance diamond.

Figure 1 shows the results for the Newly Industrializing Countries, which have been the best performers in the world over the last decade, and for the PRC, which is emerging as the best, at least in terms of its growth performance. The heavier lines show the average for the year 1991-92.

Figure 2 shows the comparable results for New Zealand for the year 1992-93. This is a better year for New Zealand compared to the 1992 and the average for the last decade but the contrast with Asia is marked. New Zealand has a diamond but it is squashed down. It does well compared to the Asian NICs and China in three indicators but very poorly in terms of the fourth - growth of GDP.

This seems to me to tell an important story. A decade of reform has brought the public sector and the balance of payments under control and it has dramatically lowered the rate of inflation but it has not yielded growth.

It is interesting too to compare the growth response of the New Zealand economy to radical reform with that of other countries. Most if not all of the Asian countries which have undertaken reforms comparable to New Zealand have resumed a higher growth path much sooner than New Zealand. Take India as the latest example. The Indian reforms began in 1991. The growth of GDP in 1991 was a mere 1.2 per cent but it picked up in 1992 to 4.0 per cent and in 1993 to 3.8 and it is expected to grow by 4.8 and 5.5 per cent in 1994 and 1995 per cent (Asian Development Bank (1994, Table A1). However, one should note that the Chilean experience resembles that of New Zealand. Real wages returned to the levels of the early 1970s before the reforms only in the last few years and the unemployment rate

reached levels consistent with those of the 1960s only by 1989. Rapid improvement in growth performance after reforms may be distinctly Asian, another feature of the amazing macroeconomic performance of the Asian economies as a group.

The slow rate of growth after a decade of radical reform is the outstanding feature of the New Zealand economy, it seems to me. What might account for it? This is much too big a subject to resolve here. But I shall comment upon one feature of the reform programme, namely, the sequencing of the reforms. Initially, in New Zealand and in other countries the sequence in which reforms are carried out received little attention but that is changing (see, for example, Papageorgiou, Michaely, and Choksi (1991)).

The New Zealand reforms began with the foreign exchange and financial markets and deregulation of foreign investment, moved to liberalisation of the trading sector and later addressed other markets, including the labour markets. In particular, labour markets were not changed greatly until the Employment Contracts Act of 1991 which overthrew the traditions of compulsory unionism and centralised wage bargaining. The New Zealand sequencing seems to be broadly similar to that in other countries such as Australia, Chile and India. In Australia the international capital markets were liberalised before the goods markets and the labour markets have been the last to be liberalised (see Lloyd (1992)).

The standard argument is that deregulation of financial markets leads to a real exchange rate appreciation (compared to what would have happened otherwise) which in turn puts pressure on the traded goods sector. This is aggravated if the import barriers and export subsidies are reduced at the same time. Failure to free up labour markets and markets which supply other important services and inputs makes adjustment to policy shocks more difficult. Hansen and Margaritis (1993, p. 35) recently concluded that "The New Zealand experience confirms that under a combined policy of disinflation and liberalisation the deregulation of the real goods and labour markets should proceed as rapidly as possible in order to ease policy pressure on the most exposed sectors of the economy." They add "However, political and economic considerations implied that it would have been unwise to delay the opening up of the financial markets and the capital account until after substantial progress had been made in liberalising trade flows and deregulating the labour market.... Moreover, for a Labour government it might well have proved impossible to have begun the reform program with the labour market."

The Brookings Institution study of Chile concludes that two important lessons on the sequence of reforms emerged from that country's experience. The first is that extensive

liberalisation of the financial sector should not take place until unit prices have been stabilised. The second is that the liberalisation of the financial sector should wait for the development of adequate supervision. The New Zealand and most certainly the Australian experience would support the latter strongly. Similar concerns in relation to sequencing have arisen in India (East Asian Analytical Unit (1994, chapter 6)).

Thus, New Zealand did not do well on the sequencing aspect of the reform programme. It is too late to reverse or undo the sequencing decisions but more attention can be paid to the present problems.

5. Some Remarks on Policy Formation in New Zealand

I want to return the objectives of economic policy. Average per capita income or expenditure, in real terms, is the most important single summary measure of the performance of the economy. Economies produce only in order to consume. (The term consumption should include consumption of public goods and we should make allowance for the depletion of natural resources and any degradation of the environment) Higher levels of output enable a society to widen the choice of private and public sector-provided goods and services. There is little question that New Zealanders now aspire to higher real incomes. And an acceleration in the rate of growth of output is a necessary condition for a substantial reduction in the unemployment rate.

The objectives of economic policies should be recast. There are only two true or ultimate objectives of economic policy - growth in real output and expenditures and the distribution of these expenditures among households.

New Zealand is in danger of becoming obsessed with the rate of inflation. The rate of inflation is not an ultimate objective of economic policy. It can be treated as a proximate objective, or rather a target variable, that is important only if it can be demonstrated that the rate of inflation is (positively) related to the achievement of an increase in real output and expenditure or to its distribution. The Governor of the Reserve Bank recently gave a speech which addressed this issue. (Reserve Bank of New Zealand (1994)). He rightly queried the view that a little inflation is right for growth but I want to query his view that no inflation is good for growth. There is little evidence for this in New Zealand or other countries (apart from hyperinflation disasters). Look at the time series evidence for New Zealand or at cross-section evidence: the Peoples' Republic of China for instance - double digit inflation and double digit increase in per capita incomes - compared to New Zealand where both the

rate of growth of per capita incomes and the rate of inflation are stuck in the 0-2 per cent band.

The rate of growth or real output depends on the rate of factor accumulation and the rate of growth of factor productivities which in turn depend upon savings rate and foreign investment, innovation, improvements in the quality of the labour force because of embodied human capital and so forth. We know very little of these processes and of how they are affected by the rate of inflation. I do not mean that New Zealand should abandon price stability but rather that it should seek to increase the rate of economic growth and if the policies adopted unavoidably raised the rate of inflation along with the rate growth of real output, so be it.

Could we rewrite the conditions of employment of the Secretary of the Treasury to make that department responsible for the rate of growth of the economy and the Secretary's continued appointment conditional on the achievement of a target rate of growth? This may not be practicable because it will be much harder to change this rate. But the nation could reorder its economic objectives and direct its policies towards the true objectives. It is time to do so.

More attention should be focused on the policies that will raise the underlying rate of economic growth. This will mean an examination of policies to raise the rate of savings in the household and business sectors, human capital formation, the selection of immigrants most likely to benefit the economy (apart from refugee and humanitarian immigration), and so on. This may call for further reform of the superannuation scheme and the tax system (see Diewert and Lawrence (1994)). Sacred cows must be sacrificed.

One implication of these spreading reforms in many countries is that New Zealand cannot afford to rest on its laurels and expect that it will reap rewards from its past reforms and the liberalisation of world trade from the just signed Uruguay Round. "Preliminary analysis leaves little doubt that New Zealand will be a major beneficiary of the Uruguay Round over the next decade. Increased market access and export prices, particularly for agricultural products, should boost our annual export returns by more than NZ\$1 billion over the next decade...The effects on New Zealand's overall Gross Domestic Product (GDP) growth are difficult to estimate. Conservative estimates suggest the GATT outcome could increase New Zealand's GDP by 2-3 per cent in the next decade." (Ministry of Foreign Affairs and Trade (1994, pp. 7,9). The world economy will become even more competitive as the unilateral and multilateral reductions in barriers to trade in commodities and factors take effect.

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Chronology

The first reforms related to the financial sector. The Prime Minister-elect announced a devaluation of the New Zealand dollar on 18 July 1984 and the removal of controls on lending and deposit rates. A month later the Governor of the Reserve Bank announced that the Bank would commence open market operations in the government securities market for the first time in New Zealand history. The following year the Government removed the restraints on the number of trading banks and strengthened the Reserve Bank's powers of prudential supervision of the banking industry. It developed a new monetary policy, to be carried out by the Reserve Bank, whose primary objective was price stability. The instruments of monetary policy shifted from the traditional ratio controls and direct controls over interest rates and lending to targeting primary liquidity of the banks. (See Reserve Bank of New Zealand (1986) for a detailed chronology and account of changes in monetary policy.)

The reforms soon moved on to the reform of the troubled foreign exchange market. On 31 October the Reserve Bank abolished the rules which had previously limited private overseas borrowing and on 21 December exchange controls were relaxed, permitting residents to borrow and invest abroad. On 2 March 1985 the Minister of Finance announced that the New Zealand dollar had been floated.

The government also moved swiftly to reform the trade policies. In 1984 the import liberalisation programme began. Import licensing, the main form of border protection in New Zealand since 1938, ended in 1986. In 1987 a four-year tariff reduction programme began. For exportable commodities, export performance taxation incentives, the main form of direct export subsidies, were phased out between 1985 and 1987, after the phasing out of agricultural subsidies had begun in late 1984.

Numerous other reforms were introduced. In the public sector, the government moved to reduce the fiscal deficits. In 1986 a broad-based single-rate value added tax, the GST, was introduced and the rates of taxation on personal income were sharply reduced. The government introduced a number of microeconomic reforms of the public sector the following year which were designed to improve the efficiency of that part of the national output which is produced in the public sector. These included the corporatisation and later the privatisation of state-owned enterprises producing private market goods.

Many other areas of policy were subjected to major changes. These included welfare policies, labour market regulations, the regulation and management of natural resources and the environment, and so on.

FIGURE 2

New Zealand

1992-93

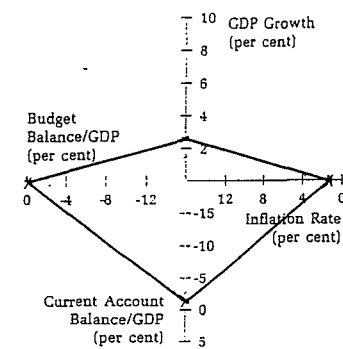
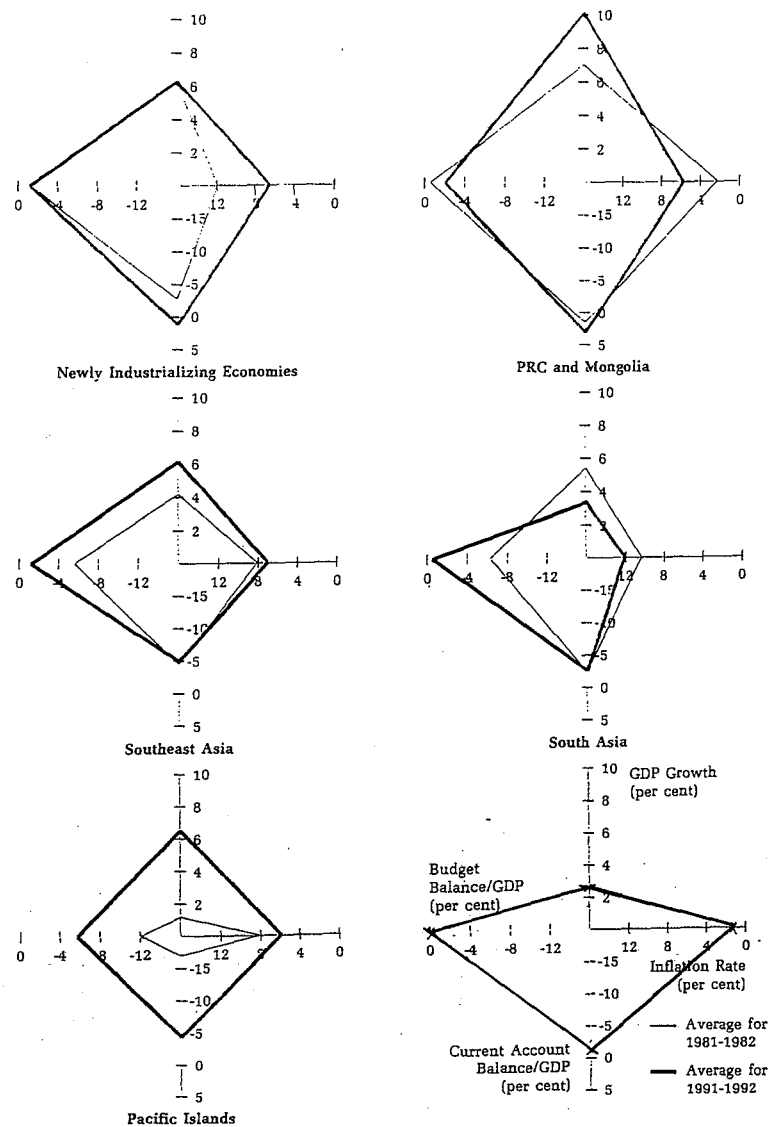


Figure 1 Selected Development Indicators for DMCs: 1981-1982 and 1991-1992



Source: Data from Asian Development Bank, Economics and Development Resource Center (ADB, EDRC).

"The Way Ahead"

By Graham Robertson

For the

Annual Conference

NZ Agricultural Economics Society

"1984-1994 Ten Years of Progress?"

Blenheim

1-2 July 1994

We are now ten years on from the advent of Rogernomics. It has been a difficult and challenging decade and the effect on farming has been profound.

As farmers we went through a series of stages, or mood swings as economic reform took hold.

We initially supported liberalisation. Farmers, more so than any other group in the production sector supported the need for change.

We knew that an inefficient internal economy was undermining our ability to compete on world markets.

We also knew that the bandaids being applied to our industry by way of subsidies to compensate for the high internal costs and overvalued dollar, were not a durable solution.

We knew too, that we could not rely on an ever depreciating currency to keep us competitive.

We were certain that economic reform had to be across the board, that the old notion of a competitive export sector and a protected internal economy was an absolute lunacy.

So economic reform was supported by Federated Farmers and by a majority, although not by any means all, of our members. In fact for some time prior to the 1984 election we had been saying that the interests of farming would be better served by economic reform than by continued subsidies.

But of course despite the best of intentions from the reformers of the 1984-87 Labour Government, they fell far short of our expectations. The implementation of reform was demoralising for farm families.

Firstly they were not even-handed. The support to agriculture was withdrawn before other sectors were dealt with. There are those who believe the reforms should have been phased more slowly and that people should have been given time to adjust. But I personally subscribe to the "big bang" theory. The cost of adjustment in an industry such as ours was much higher than it should have been, while we waited for the benefits of reform elsewhere.

Secondly was the problem of sequencing. That the finance sector was deregulated before the other reforms were at least well under way imposed further costs on the industry.

Finally there was the problem of inflation during the period. Certainly the government was always going to have difficulty controlling inflation once the Muldoon inspired controls were removed. But their leadership was abysmal. When the review of their own parliamentary salaries concluded that a massive "catch up" was in order, they professed reluctance for a brief moment before accepting the largest single salary increase, probably of all time and in any occupation in this country. This then was the signal for massive wage increases all round and the period of most rapid inflation in our history. Throw in the share market and property boom, a mad cap financial sector and farming families almost started to believe that they were part of a sun set industry.

The real damage to agriculture during the mid to late eighties was not loss of subsidies. It was the high interest rate/high exchange rate scenario used to control the inflation set alight by the Lange Government. Further damage

resulted from a financial sector that temporarily lost its marbles and wanted to get its money out of agriculture.

These were the dark times for farming with pressure on families from shortsighted bankers, Prime Minister Lange telling us we couldn't run a corner dairy and from Treasury theorists who said that the real problems with agriculture were related to unrealistic capital values. All that was needed they said, was to shift a generation of farmers off the land and move another lot on at lower prices and the industry would be competitive again. Most of you in this room today will have some idea of what individual farm families went through. With incomes reduced, interest rates rampaging through their businesses sucking out scarce cash, and equity gone from the balance sheet, survival looked a little difficult.

But the experts totally misunderstood the attachment of a farm family to their land. While those at risk included some whose ability was not up to the job, many were the cream of our farmers. The top operators who expanded and developed but whose worse case scenarios never envisaged 25% interest rates, \$180/tonne wheat and \$15 lambs. But these farmers had a commitment to their land that made them difficult, in most cases impossible, to displace. It is not easy to remove a farm from a family whose attachment to that land, and deep sense of injustice will enable them to fight to save it.

But I have no wish to dwell on this period.

Our mood as farmers started to change again as the rest of New Zealand began to feel the effects of restructuring and the benefits became bankable to the export sector.

We saw our ports become internationally competitive as they worked 24 hours a day, 7 days a week.

Freezing works for the first time in our memories ceased to be the refuge of overpaid, prima donnas.

The State Sector reforms were dispatching armies of bureaucrats to a more productive life elsewhere.

The Employment Contracts Act removed the nonsense of national awards and general wage orders that were the refuge not just of employees. Employers too often enjoyed the idea that their competitors could not steal a march by having more productive workers.

The wind back in the welfare state made life on a benefit a less attractive option to grafting in the real world.

As interest rates came down and land values recovered, we positively enjoyed the sight of banks scrambling for our business.

All this has been good for the confidence of farmers. It is confidence based on realism. That for the first time in our life time we have a competitive New Zealand economy.

That we are going to have better opportunities in international markets as a result of the Uruguay Round.

That having survived the last decade we are confident that in both the personal sense and in our businesses we can withstand whatever the future may hold.

What then does the future hold?

I will not presume to analyse the GATT outcome in such distinguished company. Suffice to say, that the biggest gain we have is that the idea is now taking hold around the world, that governments should become less engaged in the business of agriculture. Our experience as farmers is that whenever governments meddle in agriculture they invariably get it wrong. SMPs encouraged the production of million of lambs for which the freezing companies could find no markets. The Common Agricultural Policy, which was designed to achieve self sufficiency in food, has ended up with 20% over production and mountains of butter and beef and lakes of wine.

Markets that are left to farmers react much more quickly as farmers make rational responses to market signals.

We will see trade opportunities arising from the Uruguay Round but of course these are opportunities only. They still require adherence to good marketing and efficient processing.

We must continue to work hard on this matter of efficiency. We know there are other low cost producers out there who will also compete with us in a more liberal market. And we should not underestimate the competition from the Europeans themselves. Large sections of agriculture in the European Union have the ability to become internationally competitive. Just as high prices have encouraged farmers there to find expensive production methods, so too will they eventually adapt to lower prices. Already Denmark is embarking on a debt restructuring programme to enable them to become more competitive. And of course the European farmer has the advantage of a massive market just beyond the farm gate.

We must continue to invest in Research and Development both on and off the farm to retain our competitive advantage.

We will see more branding of product. Cervena, ENZA, Anchor, Fernleaf and Watties will increasingly become the means of ensuring we have a presence in the quality supermarkets around the world.

You will note I have not mentioned any meat brands. Unfortunately one of the casualties of the poorly performing meat industry has been the lack of brand investment. While "New Zealand Lamb" with its rosette is among the top six food brands in the UK, Continental Europe has yet to establish the same recognition.

Allied with brands will be the business of quality. This will increasingly be a matter that will start with the farmer. Horticulturalists and dairy farmers already understand that, deer farmers have started to deal with it, while sheep and beef farmers are only now beginning to think of a farm quality assurance.

Sustainable agriculture will become the catch cry of the future. The next GATT round will address international environmental standards. We will need to demonstrate our credentials, particularly to our European competitors, that our farming systems are sustainable to ensure access to rich markets.

We will also need to assure consumers that our environmental standards are high. In New Zealand agriculture we are in the business of producing food for affluent consumers around the world. There is no doubt that the more affluent a

population becomes, the more green are their tendencies. These consumers will be buying products that they know are derived from sustainable farming systems.

The Resource Management Act will be a valuable means of certifying our environmental standards. But it also threatens to bury us under excessive bureaucracy and compliance costs. Those who are administering the act must realise two things.

That the RMA envisages that development should take place. It is not about putting New Zealand into a time capsule and keeping the place unchanged.

And secondly that regulation should be kept to a minimum. Section 32 of the Act requires councils and the government to consider means other than regulation to achieve an objective. Enlightened councils are already trusting in voluntary actions. Education, provision of information, landcare groups, codes of practice are the best way of achieving good environmental outcomes. Unfortunately there are too many councillors and planners whose heritage is derived from the old planning days and who are unable to embrace the concepts of the RMA. Their psyche of regulation and paper war must be broken.

There is also no doubt that our farming systems, based as they are on the use of the white clover plant to underpin pastures for the grazing animal, are among the most environmentally benign farming systems to be found in the world. We have a head start in the sustainability business.

Farms will continue to be family owned. While family farms will get larger, the renewed interest of corporate owners will not last. Their entry into agriculture has been driven by the low cost of farm land in the last few years. Certainly there is sufficient profitability in the dairy industry to provide a return for both the owner and the sharemilker. But elsewhere in farming the return to the corporate investor, once the initial significant capital gain from buying at low prices has been accounted for, will be insufficient to hold them in the industry.

Finally farmers will be more conservative. Those who farmed through the eighties are as permanently affected as were those who farmed through the thirties. Certainly the speed of the recovery will diminish the lessons a little, but for most of us, a more conservative approach to gearing our businesses and maintaining current account liquidity will stay with us.

This will also be influenced by the greater risk inherent in more open markets. While this may limit the expansion of farming it will not diminish profitability.

Some might suggest that current land prices indicate that the lessons have not been well learned, that over confidence is abroad.

But the fact remains that we simply don't know if current prices are too high. We will know with hindsight.

It is also the right of anyone in the free market to squander their capital by paying too much for their land. And it is also the right of those financing them to lose their shirt as well.

Everybody knows the new rules. There will be no bail out again.

Finally can I say that there are political forces at work that would undermine the principles currently underpinning the New Zealand economy - principles of responsible management of government finances, independence of the Reserve Bank, free and open markets and greater reliance on individual enterprise.

But while these forces have their adherents among the less advantaged and the "do good" liberal fraternity, farming families are firmly in favour of the New Zealand delivered by the governments of the last ten years. After the pain we went through to get here, we must not allow New Zealand to drift back to the bad habits of old.

SECTION B
CONTRIBUTED PAPERS

Changing emphasis of agricultural support and the provision of public goods in the countryside; UK perspective

Caroline Saunders

Introduction

Intensification of land use in Europe has led to environmental problems which coupled with the growth in demand for leisure in the countryside has increased pressure for provision of public goods. In response policies have been developed to conserve and protect areas. This paper therefore firstly describes the main policy changes particularly in the UK. Two examples of policies to provide public goods are then examined in more detail. A theoretical framework for comparing the cost of these policies in achieving their objectives is developed. Finally the empirical analysis compares the cost both at national level and for selected sites.

After the second world war support for agricultural production in Europe including the UK increased. This was considered to be of paramount importance and stressed the role of the farmer in producing food. Other demands on the countryside such as landscape, wildlife, and other public goods were thought to be best provided by farmers that is, 'farmers were the best custodians of the countryside'. This was reflected in the Agricultural Act of 1947 which guaranteed prices for agricultural production and the Town and Country Planning Act 1947 which, whilst restricting property rights of urban land owners, largely excluded agriculture.

As a consequence of policy incentives and technological improvements the level of production increased. The incentives for increasing agricultural production in the UK were reduced somewhat in the 1960's but after entry into the EC in 1973 they were reinstated. However as incomes rose in the rest of the population, so did the amount of leisure time and the use of the countryside as a recreational area. As a result of this the environmental consequences of the expansion in agricultural support became more apparent especially with the growing environmental awareness of the mainly urban based population. These environmental effects included landscape and ecological changes due to the removal of hedgerows and other linear features; destruction of forests; intensification of land use with the increased use of chemicals; changes in land use in particular from grass to arable and the improvement of rough or semi-natural vegetation with the associated loss of wildlife habitat.

The protection of the countryside had been recognised in the National Parks and Access to the Countryside Act in 1949 but this had little or no impact on land use for agricultural production and was largely centred upon the planning protection in designated national parks and access arrangements to the wider countryside with some support for the establishment of nature reserves. As the pressures on the countryside increased so did the demand for conservation/protection. As a result the powers of conservation agencies were increased with the introduction of the Countryside Act in 1968 but these powers were considerably enhanced in the

Wildlife and Countryside Act in 1981. Moreover the Ministry of Agriculture Fisheries and Food, traditionally the guardian of farmers and agricultural production, showed a change in policy emphasis with the introduction of conservation policies under 1986 Agricultural Act.

In general due to the population density and intensity of land use in the UK the provision of public goods implies some conflict with existing land managers/users. Historically the alteration of land managers/users property rights has not been politically possible without some form of compensation. Whilst changes in property rights have been implemented in urban areas, such as the Town and Country Planning Act in 1947 and since then with legislation protecting ancient monuments and buildings of special interest this has been without compensation. Thus legislation which has developed to provide public goods in the countryside has tended to give compensation to farmers for loss in property rights. The two main examples of this in the UK are the designation of Sites of Special Scientific Interest (SSSI) and Environmentally Sensitive Areas (ESA) which involve management agreements to provide conservation goods. It is the operation of these that the paper will concentrate upon.

Development of Sites of Special Scientific Interest (SSSI)

Sites of Special Scientific Interest (SSSI) were first designated under the National Parks and Access to the Countryside Act (1949). The special scientific interest of these sites is due to the flora, fauna or geological or physiological features. However it was not until the Countryside Act (1968) that the Nature Conservancy Council (NCC)¹ had, under section 15, the power to enter management agreements with owners and occupiers of designated land to prevent development and loss of SSSI. The Wildlife and Countryside Act (1981) extended the powers of the NCC in protecting SSSI with owners and/or occupiers who are obliged to notify the NCC of any potentially damaging operation (PDO) which will affect the characteristics of the SSSI. The NCC then has to enter a management agreement with the owner and/or occupier in accordance with the financial guidelines given in the Wildlife and Countryside Act (1981). Compensation is then payable based upon the financial opportunities foregone, that is the difference in profitability between current and proposed land uses.

The NCC offer four types of payment to owners/occupiers under management agreements, annual, capital, other non-recurring and other recurring. Annual and capital payments are based on profits foregone, and arise from a PDO. Annual payments are for a range of time periods, up to 21 years, and provision is made for renegotiation to allow for changes in farm profitability, typically every three years. An early intention that annual payments should be adjusted annually by indices was never implemented. Capital (or lump-sum) payments are typically for 20 or 21 years. Other non recurring and recurring payments are for positive conservation management, and cover such activities as scrub clearance and fencing. All management agreements are individually negotiated and owners/occupiers are reimbursed for professional negotiation fees.

¹Since 1991 the Nature Conservancy Council (NCC) has been replaced by four organisations. However in this paper it is, for convenience, still referred to as the NCC.

At the end of the financial year 1989 there were 5,000 SSSI covering 1.64 million hectares, and there were some 1,500 management agreements covering 87,000 hectares. The cost to the NCC was £6.4 million over 1988/89. Despite the work of the NCC to safeguard SSSI and the declining threat from agriculture as profitability falls, damage still continues. In 1988/89 181 SSSI or proposed SSSI suffered short term damage, 82 of these (30,000 hectares) was due to agriculture with the damage being in 92 per cent of cases from overgrazing (NCC pers comm). This reflects the limitations in the current system of protection which is more effective when there is a proposed change in farming system but less effective when a more subtle change, such as increases in stocking rate, occurs.

Development of Environmentally Sensitive Areas (ESA)

In the early months of 1985 the Ministry of Agriculture invited the Department of the Environment, the Countryside Commission (CC) and the Nature Conservancy Council (NCC) to help draw up appropriate criteria for selecting candidate areas: The following points were established:

each area must be of national environmental significance;

its conservation must depend on adopting, maintaining or extending particular farming practices;

farming practices in the area must have changed, or must be likely to do so in ways that pose a threat to the environment;

each area must represent a discrete and coherent unit of environmental interest.

Thus while environmental value was clearly an essential pre-condition of designation it was not the sole factor to be taken into account. In England ten areas were initially designated and by 1992 the area designated had risen to 0.8 million hectares with 6000 farms under agreement covering 285,000 hectares.. From 1993 a further six areas were designated and under current agri-environment proposals another six are proposed.

Participation is voluntary and farmers in ESAs are offered a five year agreement which awards them an annual payment in return for following a prescribed set of farming practices. Typically the prescriptions cover a range of daily and seasonal farming practices and include both restrictions and prohibitions (e.g. drainage works, fertiliser use, grazing levels) and some positive works (e.g. maintenance of hedges, barns, ponds). Many of the prescribed practices will also have a direct impact on the reduction of pollution. Both the practices and the rates of payment are standard within areas, but differ between one ESA and another.

Each farmer is required to complete a plan identifying the features of the farm to which the prescribed practices will apply. The plan enables the standard prescriptions to be applied to the specific circumstances of each farm. In some areas second or alternative tiers of management prescriptions provide a further means of varying the standard agreement to accommodate local variations in farming practice. The alternatives may increase the range of management options that a farmer can take up, for example, in some areas by reverting arable land to grassland, or they may offer a more restrictive grassland management system in return for a higher rate of payment.

The rates of payment take account of the actual and potential profits which a farmer forgoes by following the prescribed management practices. Allowance is also made for such factors as the financial security which the agreement will provide, the typical size of farms in the area, as well as their existing cropping patterns. The payment made to individual farmers is the standard rate per hectare multiplied by the hectareage covered by each tier of management prescriptions.

Comparison of the SSSI and ESA

A number of studies have examined the operation of SSSI and ESA. These include estimates of the public exchequer and social cost of compensation under management agreements Bowers (1985) and Saunders et al (1987). Other studies have compared the current system of management agreements based on opportunities forgone with other methods of compensating farmers Colman (1992), Whitby et al (1990). Also the two mechanisms have been compared in Brotherton (1991) and Hodge (1992) which discussed the differences between the protected status. However these have concentrated upon the cost per hectare of land under management agreement rather than cost of protecting designated areas.

The costs of compensation for and of negotiating and monitoring SSSI agreements are displayed in Table 1. This shows not only compensation cost which accounts for 76 per cent of the total but other costs as well some of which are estimated. This gives rise to cost per hectare in SSSI of £8 and for area under agreement of £95.7. This relatively low cost of protection was not consistent with earlier expectations about the cost of management agreements under SSSI. Gould estimated that the cost of compensation would rise from £4.4m in 1984/5 to £18.2m in 1989/90 (Gould 1985) on the expectation that producers would propose PDOs when there was no intention of improvement and also negotiate for highest level of compensation possible. In the event this has not happened for seemingly a number of reasons, firstly the private cost of negotiation, whilst NCC pays cost of landowners and occupiers costs this will only be direct costs and not cover the costs of the time involved or other indirect costs. Also the individual negotiation between occupier and regional NCC land agents has resulted in significant informal low cost agreements not using the full procedure required for a management agreement

Table 1 Estimated Aggregate Costs of Section 15 Management Agreements on Agricultural Land 1988/9

	Aggregate Cost £m (1988/9 prices) or area (thousand hectares)
Estimated Cost of Compensation	5.58
NCC Professional Advisors	0.24
Landowners' and Occupiers' costs	0.25
NCC Staff and Overhead costs	1.30
TOTAL EXPENDITURE	7.37
TOTAL AREA OF SSSI (thousand agricultural hectares)	915
AREA UNDER AGREEMENT (thousand agricultural hectares)	77
Cost per hectare of SSSI	8.05
Cost per hectare of agreement	95.7

Source: Whitby and Saunders 1994

The number and area of ESA agreements is illustrated in Table 2. Here it can be seen that the rate of uptake was very rapid in the first two years of the scheme but levelled off thereafter. The average cost per hectare of agreement fell steeply after the first year, but showed no particular trend for the rest of the period at around £90 per hectare.

Therefore by examining the average costs per hectare of SSSI and ESA it can be seen that the cost of protecting area is lower under SSSI whereas cost of management agreement is similar.

Table 2 Number and Area of Agreements: ESAs in England: 1987 - 1991

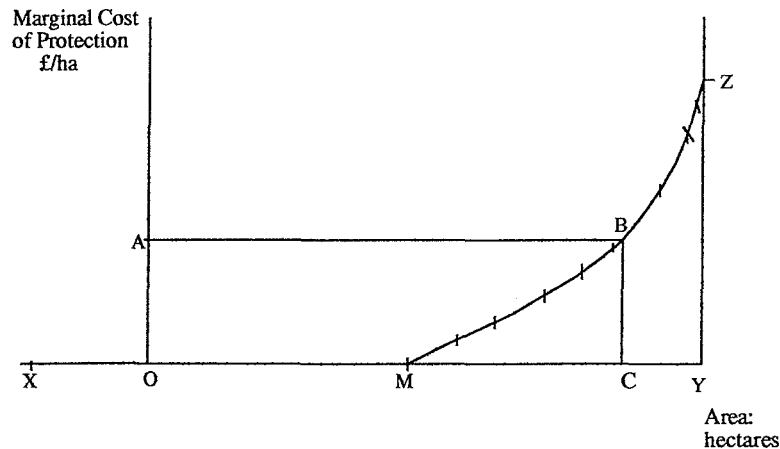
	1987	1988	1989	1990	1991
No of Agreements	1,330	2420	2770	2956	3061
Total Area, hectares	31,230	99,930	108,900	111,550	113,110
Total ESA Cost, £ m	4.9	9.3	9.5	10.5	11.1
Mean Cost, £ per hectare	156.9	93.1	87.2	94.1	98.1

Source: MAFF 1990 and MAFF 1988-91.

Theoretical model to compare SSSI and ESA

A theoretical model comparing the designation of an ESA with that of an SSSI on the same area of land is shown in Figure 1. The whole area of an ESA is represented here by XY on the horizontal axis. The area represented by XO is the land which does not need or receive protection because it would not be damaged by cultivation (bare rock for example) or because the land is not capable of being farmed using traditional methods. By contrast an SSSI would probably have been drawn to exclude XO as being of no interest from the point of view of farming. The area from O to M is not subject to Potentially Damaging Operations (PDOs), and hence management agreements are not required to protect it. From M to Y management agreements have been negotiated and are arranged in order of increasing cost per hectare up to the highest level YZ. Given that the compensation paid reflects income foregone by the proprietor, the curve OMZ follows the supply price of the conservation goods generated within the SSSI. It therefore reflects the increasing willingness of farmers and landowners to enter into such agreements as the compensation offered grows.

Figure 1 A Theoretical Comparison of ESAs and SSSI Agreements



The area beneath this curve (MYZ) then represents the total compensation bill for the SSSI. But notice that the SSSI mechanism protects the whole area at risk from PDOs, namely OY. If we wish to calculate the average cost per ha protected by the SSSI it is arguable that the appropriate denominator of the fraction is the area OY, which represents the whole area protected, rather than MY, which represents the area under agreement.

The point where OMZ intersects the level of ESA payments AB - at B - shows how much of the land within an ESA would not be entered into agreements because the income foregone, represented by BZCY, would be higher than the payments offered. Comparing the cost of protection in ESA and SSSI then becomes a problem of dividing the whole area protected into the total cost as reported in Tables 1 and 2. The appropriate area for dividing into ESA costs is the area subject to agreements, which means that the per hectare rate of compensation payments, represented by OA or BC, will suffice as an indicator of cost per hectare. The average of £93.1 per hectare. But for SSSI a somewhat lower cost than the average per hectare level of payments (is appropriate, reflecting the size of the area protected. For SSSI as a whole, the agricultural area under agreement was 77,000 hectares while the area protected amounted to 915,000 hectares. This would imply to £8.05 per hectare. This contrasts with the £95.7 per hectare for land under agreements reflecting the fact that less than ten per cent of the agricultural area of SSSI is under agreement. It is arguable that the level of management for conservation in SSSI as a whole is inferior to that practised on ESA agreement land, in which case the £8.05 per hectare should be seen as a lower estimate of value. By the same token the £95.7 per hectare is an upper limit of cost.

The use of the inappropriate denominator (MY) in calculating average costs reflects the conventional approach of analysing these arrangements at the level of the agreement. If we shift the focus to the policy-relevant level of the area protected (OY), then a different configuration of costs emerges and the conventional view becomes less appropriate. In terms of Figure 1 the

difference between ESAs and SSSI is that the former allocates a producer surplus of ABMO to farmers and landowners whilst negotiating individual agreements secures (saves) that sum for society. Nevertheless, the problem remains that in comparing the average cost per hectare in ESAs and SSSI we are dealing with areas that vary, perhaps systematically, in the intensity of agriculture they support. The next step must be to apply this model to SSSI of particular types of habitat, so that comparisons with individual ESA can be made.

Costs by Type of Habitat

To compare cost of ESA with SSSI in more detail various alternatives were considered. Given that they should measure the quantity of public good provided an obvious method would be to use some ecological or scientific measure of the site quality. The only one of these readily available was habitat type. However, the NCC definition of habitat types is not refined enough to distinguish between quite different types of public good provision: for example, neutral grassland is the most common habitat type under agreement and this covers areas varying from marshes and wetlands in the South West to hay meadows in the North East of England. Whilst they may have some similar ecological characteristics there will also be important variability. In the absence of any ecological or scientific valuation, another means of comparing ESA and SSSI would be to pick areas closely matched in terms of location and public good provision, with similar current uses and threats to land use. Ideally the SSSI would be located within an ESA and whilst recognising that there would be differences between the prescriptions of the two types of management agreement, the SSSI being more stringent and possibly more varied, comparisons would be more meaningful. A further consideration in choosing sites to compare were that the SSSI must have sufficient management agreements to allow construction of a supply curve.

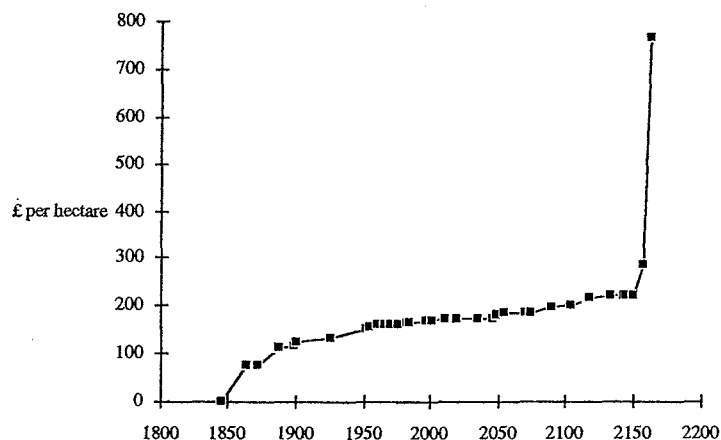
It must be emphasised, however, that the method of selecting areas with SSSI for comparison may have introduced bias, as these are only chosen for analysis if they have a large number of agreements and are close to an ESA in location and type, it excludes the majority of SSSI which have only a few agreements. This will reduce the number of SSSI to compare with ESA particularly in the uplands. Thus only 14 per cent of the SSSI area is lowland grass or heath; but they account for 63 per cent of area covered by management agreements, whereas in contrast the uplands account for 65 per cent of SSSI area but only 15 per cent of land under agreement. Thus the sites suitable for analysis will tend to be in the lowland where the cost of SSSI protection is substantially higher than the national average per hectare.

Data for two sites are presented here firstly in the Somerset Levels and Moors ESA, which allows a direct comparison between an ESA and SSSI; and SSSI in the South East close to the South Downs ESA. The main objectives of the Somerset Levels and Moors ESA is to conserve wetlands and their associated habitats. Producers can enter into two tiers of management agreement both requiring extensive management of grassland with tighter prescriptions for Tier 2 land. In return for agreeing to comply with these restrictions initially for five years producers in Tier 1 land receive £82 per hectare and on Tier 2 land £12 per hectare. This is 27,120 hectares of which 86 per cent is eligible for management agreements and in 1991 the uptake was 9,640

hectares (41 per cent) of which 8,110 hectares was in Tier 1 and 1,530 hectares in Tier 2. The ESA scheme was revised in 1992 with tighter management prescriptions and an additional tier introduced, all with enhanced payments of £120 per hectare for Tier 1, £180 for Tier 2 and £350 for Tier 3 which involves arable conversion. However, it is the original scheme which is compared with SSSI in this paper.

The Somerset Levels and Moors ESA contains 12 SSSI covering 5,920 hectares on 22 per cent of the ESA. The main objective of these SSSI is similar to the ESA in protecting the wetland habitat. In 1991 the NCC had 170 management agreements covering 1,835 hectares and it is a sample of these that is compared with the ESA. Data on the individually negotiated agreements for the SSSI were obtained from the NCC Land Agency Module, the NCC computer data base, and refers to 1989. It should be noted that these costs do not include any element of administrative or transactions cost.

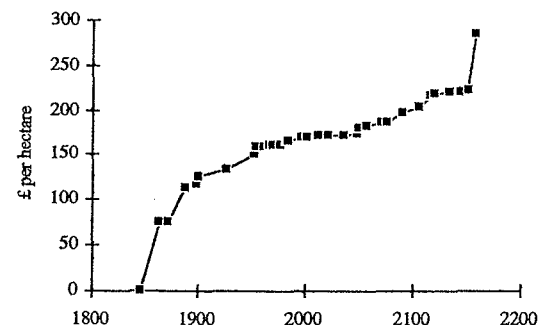
Figure 2: Cost per hectare of Selected South West SSSI Management Agreements



Source: NCC: Land Agency Module

The cost of management agreements for a subset of SSSI is illustrated in figure 2. The y intercept occurs at 1846 ha, representing the area on which there are no MAs. From that point onwards the process have been calculated as the average rates of compensation negotiated per hectare with the observations arranged in ascending order of this value which is here taken as equivalent to a price. The curve rises relatively steeply at first as land comes under agreement, after that it is fairly constant apart from the one agreement reached at comparatively high level of compensation, illustrating the point that comparatively small areas of SSSI attract substantial payments. However, this relatively high payment reduces the ability of the figure to portray the change in other levels of payments more clearly and has therefore been excluded in figure 3, which shows that most agreements are between £100 and £220 per hectare.

Figure 3: Cost per hectare of Selected South West SSSI Management Agreements: excluding an outlier



Source: NCC Land Agency Module

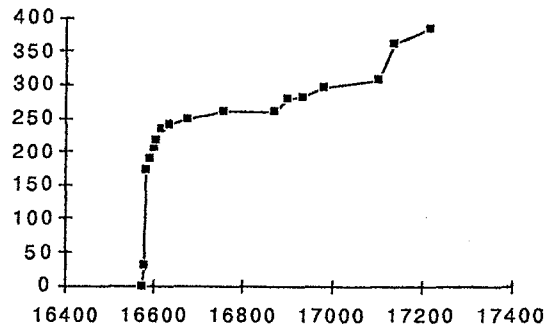
The existence of 1846 hectares not subject to a management agreement suggests at first sight that there has been no threat to this area or that NCC has secured its conservation through other means such as persuasion or education. However, in this case a part of the area under control of other conservation bodies such as the RSPB, and Nature Conservation Trusts.

So although cost of protecting these SSSI to the NCC was on average £26 per hectare which compares favourably with payments under ESA agreements the cost of the other agencies is excluded. The average cost of management agreement on land covered by agreement is £173 per hectare - higher than that for ESAs.

The second example was in the South East where the existence of relatively large number of SSSI agreements enabled a supply curve to be constructed. This is illustrated in figure 4 which shows an area of 16573 hectares not under agreement with an average payment per hectare of SSSI of £11 and £288 per hectare of management agreement.

The threats to these SSSI are largely conversion of livestock grazing land to arable and the loss of wetland. In terms of location this site is closest to the South Downs ESA. The objectives of this ESA are many and do include maintenance of wetland although it is predominantly concerned with chalk downland. Therefore the public goods provided by the SSSI and the ESA may differ. In addition the management prescriptions for ESA under Tier 1 are concerned with more extensive use of grassland, attracting a payment of £35 per hectare and arable conversion to livestock for £160 per hectare, neither of which corresponds to specific threats in the SSSI. In this case, therefore, comparisons should perhaps be made between the SSSI and ESA such as the Broads or Brecklands offering payments ranging from £100 per hectare for Tier 1 to £200 per hectare for Tier 2 and even £300 per hectare for uncropped land).

Figure 4: Cost per hectare of Selected South East SSSI Management Agreements



Source : NCC: Land Agency Module

The results of these habitat-specific comparisons are summarised in table 3. It is emphasised that the low figure for SSSI is to be seen as a lower bound estimate, for the reasons stated earlier, whilst the higher figure is the actual average per hectare of agreement. By contrast the ESA payments simply portray the range of payments available for different levels of participation in the relevant ESAs. The conclusion to be drawn from this comparison is similar to that for aggregate data reported in the first section of this article, namely that the cost per hectare of management agreements is broadly similar under the two arrangements. However, if, as seems reasonable, we are prepared to recognise that SSSIs bring a measure of protection to the whole area designated, then it follows that the SSSI arrangements are a substantially cheaper means of protecting conservation sites in terms of financial costs.

Conclusion

Agricultural and environmental policy in Europe as well as elsewhere is entering a new phase of development. Although the current CAP reform package is radical in its coverage and movement towards decoupling support from production, there are indications that it is not sustainable either financially or politically. In the longer term, opportunities for tying environmental compliance to agricultural support payments seem ripe for exploitation, not least as a way of deflecting public criticism of paying farmers for doing nothing (setaside). This may lead to wider acceptance of the notion of paying farmers to produce public (ie. environmental) goods rather than food.

At present mechanisms in the UK are based upon voluntary and compulsory management agreements which modify property rights with compensation. However, there is ample scope for modifying such arrangements by, for example, varying the level of compensation and degree of compulsion. This paper has compared two such mechanisms and shown that individually

negotiated management agreements under section 15 of the Wildlife and Countryside Act 1981 have tended to result in lower cost per hectare protected in SSSIs than the flat-rate payments in ESAs due to the ability to negotiate with farmers at an informal level. This is despite the fact that a few management agreements under section 15 are relatively costly in terms of compensation for producers.

How far this system of compensating farmers for alteration in their property rights is applicable to New Zealand is open to debate. New Zealand has not had the same degree of support for its producers who have had to operate at low world prices and therefore the incentive to intensify production. Also the areas which have the greatest pressure for demand for public goods in New Zealand have typically low production potential and therefore less potential for conflict. Moreover New Zealand has a history of modifying property rights in rural areas without compensation. However there may be a place for compensation where costs to existing owner occupiers of change in land use are great such as management of native forest or expansion of native bush.

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HAS THE RESOURCE MANAGEMENT ACT KILLED ZONING ?

a paper contributed to the NZAES Conference 1/2 July 1994, by:

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Abstract.

Local authorities in New Zealand have for many years used the technique of zoning to direct and control development of land and resources. The power to use zoning was enabled through a number of Acts of Parliament, principally the Town and Country Planning Act 1977.

With the passage of the Resource Management Act 1991, a number of clauses were included that appeared to question whether local authorities could rely upon zoning as the principal regulatory mechanism. These clauses included Sections 5 and 104 which focused on the effects of land use rather than the use of land; and Section 32 which required a party in exercising responsibilities under the RMA to validate the efficiency and effectiveness of any rules proposed. Zoning is designed to control land use, not necessarily the effects of land use, thus may not be the best instrument to focus on effects. Similarly zoning may not be the most efficient or effective instrument to control the effects of land use. Economists have long asserted that the most efficient method to manage resources is to allow market forces to operate. An interpretation of the RMA that was made by some economists was that these sections enabled a market interpretation of land use.

Such an interpretation may be misplaced however, when one understands the ideology of those administering land use planning. An insight into administrator's ideologies can be gleaned from submissions to the Bridgeport Group Report (1988), which reviewed submissions from primarily regional and local bodies on the future role of local and regional government in the RMA. To the question, why do natural and physical resources require regulation, many gave the explanation that 'unbridled market forces must not prevail in determining patterns of use and/or exploitation of natural resources' (ibid p3). To the question, which resource management matters are better dealt with by voluntary mechanisms, there was 'strong objection from all groups.... to allow market forces to decide the use of natural resources. A comment was made that "most regulatory systems exist to protect the powerless from the unscrupulous"' (ibid p6). Administrators of the RMA are thus not likely to take as 'liberal' interpretation of the RMA as economists might.

In essence then, the RMA has set the stage for conflict between developers, who have the support from many development interests (including many economists), and 'the powerless', represented primarily by those involved in regional and local authorities. This paper analyses this power conflict by considering some of the allocative and distributive outcomes involved.

WHY ZONE?

The rationale for zoning in New Zealand has been enunciated by Turner SM in J H Tutbury Ltd v Tauranga City Council (1978), when he said; 'Zoning theory requires the separation of residential, commercial and industrial uses in order to avoid the indiscriminate mixture of incompatible uses, to preserve and enhance amenities, to economise in the servicing of the area, and to promote convenience, health and safety.' (ibid p441). Webster defines a 'theory' as 'an exposition of the general principles of an art or science as distinct from the practice and execution of it', and 'principle' as 'a comprehensive and fundamental law, doctrine or assumption'. Turner does not describe what 'zoning theory' is in any further detail, but the principle of the theory is plain - the use of law to separate land use in order to meet the public and private aims that Turner specifies. Zoning is a technique to regulate land use, yet there is no 'comprehensive or fundamental law' that requires land to be zoned. Why zone land then, and why should a senior as land judge as Turner wish to elevate the technique of zoning to the realm of a theory?

Babcock (1966) in an early text puts forward two distinct theories of the purpose of zoning which he refers to as the 'property value' theory and the 'planning' theory.

The Property Value Theory of Zoning

The basic axiom of the property value theory is 'that each piece of property should be used in a manner that will ensure that the sum of all pieces of property will have a maximum value, as determined by market forces. In other words, every piece of property should be used in the manner that will give it its greatest value without causing a corresponding decrease in the value of other property' (ibid p117). Thus while the 'proper' zoning of property is determined by market forces, zoning rules are seen to protect the market from imperfections in the natural operation of supply and demand. In particular, zoning rules can achieve the goal of allowing land to be allocated to its highest and best use by prohibiting the construction of 'nuisances' - nuisances being any use which detracts the value of other property to a degree significantly greater than it adds to the value of the property on which it is located.

Thus the property value theory justifying zoning which begins with a belief in market forces to maximise the value of land evolves into a system of control of land use by whoever has control of the 'public interest'. Babcock however considers that in this system of control the scope of 'interaction' of land use is decided by whoever has control of the public interest. Also the same group decides on the degree of adverse impact, a decision influenced by whether compensation should be paid or not. Because zoning is controlled by whoever has control of the public interest, the property value theory thus becomes part of the political process and subject to political rules.

The Planning Theory of Zoning

According to the Planning Theory for zoning, zoning is merely one of a number of methods of putting into effect an overall municipal plan (Babcock, op cit p121). Hall (1992) defines planning as a general activity as 'the making of an orderly sequence of action that will lead to the achievement of a stated goal or goals (ibid p3). Urban planning Hall refers to as 'planning with a spatial, or geographical, component, in which the general objective is to provide for a spatial structure of activities (or of land uses) which in some way is better than the pattern existing without planning' (op cit p4). Hall does not discuss the obvious questions that result from this statement - for whom is planning better; how much better is 'some way', who decides what is better? Implicit in Hall's discussion is that elected officials and planners have the ability to answer and manage these questions.

The urban plan as described by Hall 'starts with the formulation of goals and objectives for the development of the area concerned... Against this background the planner develops an information system which is continuously updated as the region develops and changes. It will be used to produce various alternative projections or simulations, of the state of the region at various future dates, assuming the application of various policies. Then the alternatives are compared or evaluated against various yardsticks derived from the goals and objectives, to produce a recommended system of policy controls which in turn will be modified as the objectives are reexamined and as the information system produces evidence of new developments' (op cit p9).

In the planning theory context then, the validity of zoning is only measured by its consistency with the urban or municipal plan. The purpose of the urban plan is to represent development objectives for the community. These developmental objectives make provision for all the uses that the legislative body of the municipality decides are appropriate for location somewhere in the municipality; makes provision for the intensity of their use; and makes provision for the location of these uses.

Babcock identifies several difficulties with the planning theory justification for zoning. With the planning theory, control of private development is in the hands of those who control the municipal plan. As with the property value theory, this control is by whoever has control of the 'public interest', and thus becomes part of the political process and subject to political rules. As with the property value theory, because zoning is an outcome of the political process, there is difficulty with defining the scope of local control (the public control) over private development and with the extent to which the public can take without compensation. As the opening statement from Turner suggests, such scope for public intervention in land use is very wide.

In both views of zoning, the land market is replaced with the political market. An issue to be resolved is whether the land use allocation through the

political market process is more efficient and equitable than through the market allocation process.

ZONING IN NEW ZEALAND

Zoning is well established as a technique to direct and control development in local authority areas in New Zealand. Scobie and Jardine (1987) in tracing the development of zoning in New Zealand find that zoning was initially used to meet public concerns about public health and safety but extended over time to direct and control virtually all forms of development. The development of zoning in New Zealand seems to mirror the degree of involvement of the public sector in economic development.

The power authorising local authorities in New Zealand to zone comes from the transitional provisions of the Resource Management Act 1991, (RMA). Sections 373 and 374 of the RMA allow for existing district schemes and their provisions to become in whole or in any part transitional district plans and district rules under the RMA. Section 377 of the RMA place an obligation for local authorities to review these transitional district plans within ten years the district scheme became operative.

The transitional district plans were prepared under the Town and Country Planning Act 1977.

Sections 3 and 4 of the Town and Country Planning Act 1977 provide statutory requirements for any district scheme. Section 3 requires that matters which are of national importance shall be recognised and provided for.

Section 4(1) of the Act states that the purpose of regional, district and maritime planning is :

'the wise use and management of resources, and the direction and control of the development of a region, district or area in such a way as will most effectively promote and safeguard the health, safety, convenience, and the economic, cultural, social and general welfare of the people and the amenities, of every region, district or area.'

Section 36 and the Second Schedule of the Act then provide local authorities, through the district scheme, with legislative means to implement the purposes of the scheme by various 'controls, prohibitions, and incentives relating to the use or development of any land, area or building...'

Existing district schemes in New Zealand thus seem to have been developed in accordance with the planning theory as outlined by Babcock. Zoning is justified as a means of implementing the purposes of national legislation as interpreted by local authorities with the emphasis placed on controlling development.

THE RESOURCE MANAGEMENT ACT AND ITS INTERPRETATION

The Resource Management Act (RMA) came into effect on 1 October 1991. A large number of amendments were promulgated in July 1993, significantly changing the focus of some sections of the RMA.

Commentators (eg Randerson, 1990) believed the RMA moved "away from the concept of direction and control of development, inherent in the 1977 Act, towards a more permissive system of management of resources focused on the control of the adverse effects of the activities on the environment.

Zoning by territorial authorities is enabled in the RMA through an elaborate hierarchal structure of regional policy statements and regional and district plans and rules.

The functions of territorial authorities are described in s 31 of the RMA. Consistent with the purpose of the RMA, the functions of the territorial authorities are concerned with the effects of activities on resource use, particularly with respect to land, in their districts.

In an apparent endeavour to ensure efficient regulation, s 32 includes a directive to the Ministers and local authorities. Before any action is taken, the person or body must have regard to the extent to which the intervention or prescription is necessary. Thus in addition to the amendments to sections 104 and 105, in any reviews of district plans, local authorities will have to justify any political ends or intervention they make as being more efficient and effective than achieving the same or other ends by another method. One such comparison is whether the market mechanism is more efficient in achieving community aims than the political mechanism.

Under s 76, a territorial authority is allowed to include rules in its district plan which "prohibit, regulate or allow activities" for the purpose of allowing the authority to carry out its purpose under the Act and to achieve the objectives and policies of the plan. Section 76 apparently envisages a zoning system by specifying: (1) permitted activities, (2) controlled activities, (3) discretionary activities, (4) non-complying activities, and (5) prohibited activities (s 76 (3)). In the same vein, s 76 (4) states a rule may-

- (a) Apply throughout a district or a part of a district:
- (b) Make different provision for-
 - (i) Different parts of the district; or
 - (ii) Different classes of effects arising from an activity:
- (c) Apply all the time or for stated periods or seasons:
- (d) Be specific or general in its application:

- (e) Require a resource consent to be obtained for any activity not specifically referred to in the plan.

Part VI of the RMA deals with resource consents. Five categories of resource consent are defined under s 87; a "land use consent", a "subdivision consent", a "water permit", and a "discharge permit". These categories arise out of and depend on the provisions within the regional and district plans. It would be expected for instance that the "land use consent" would include under the district plan the sub-categories of a "controlled activity", a "discretionary activity", a "non-complying activity", and a prohibited activity" (as contemplated under ss 76(3) and 76(4)). These land use activities are defined in s 2.

The critical sections in relation to decisions by an authority on resource consents are ss 104 and 105. Consent may not be granted at all for prohibited activities but may be granted for controlled, discretionary, or non-complying activities.

The exercise of discretion in respect of a controlled activity is severely limited. Subject to S 106 (relating to subdivision) and s 107 (relating to certain discharge permits), the consent authority is obliged to grant consent to a controlled application and has discretion only in respect of conditions imposed under s 108, or s 120 for a subdivision consent. In considering conditions, the consent authority is obliged to have regard to s 104. Sections 104 and 105 were substantially amended in July 1993. The changes made to section 104 and 105 seem to illustrate an intent by the law makers to weaken the power of local authorities to regulate land use by zoning.

The particular subsections of the original section 104 that appear of importance to zoning issues are subsections (1) and (4).

" ... (1) Subject to subsection (2), when considering an application for resource consent, the consent authority shall have regard to any actual and potential effects of allowing the activity.

...

(4) Without limiting subsection (1), when considering an application for resource consent, the consent authority shall have regard to-

- (a) Any relevant rules of a plan or proposed plan; and
- (b) Any relevant policies or objectives of a plan or proposed plan; and
- (c) Any national policy statement, New Zealand coastal policy statement, and regional policy statement; and
- (d) Where the application is made-
 - (i) In accordance with a regional plan, any relevant district plan; and
 - (ii) In accordance with a district plan, any relevant regional plan; and
- (e) Any relevant water conservation order; and
- (f) Any relevant draft water conservation order;

The amended s 104 (1) reads

'subject to Part II, when considering an application for a resource consent and any submissions received, the consent authority shall have regard to -
 (a) Any actual and potential effects on the environment of allowing the activity; and
 (b)....

...similar conditions to s 104(4) above.

This amendment in principal removes any reliance local authorities may place on the integrity of their territorial plans as justification for zoning ordinances. The key difference is the removal of the words 'shall have regard to any actual and potential effects of allowing the activity' from the original s 104(1) and their replacement in the amended s 104 (1) (a) with the addition of the words 'on the environment' after 'potential effects'. This change appears significant to zoning as it follows the decision in Batchelor v Tauranga District Council (1992), where under appeal to the High Court, the Court ruled that;

"Zoning is a method of resource management. and, under a transitional plan, activities are regulated by that means. It must, for present purposes at least, be accepted that the zoning provisions of the plan are appropriate, and the prohibition against a liquor outlet as a use in the area in question must be a further factor to be considered. The starting point is that such a use is not permitted as of right. Here the Tribunal has weighed up the advantage of using the site for the intended purpose against the competing considerations of adverse effects on the integrity of the district plan. That exercise was not carried out in a way which contravened the terms of the purposes of the Act."

What seems apparent from Batchelor v Tauranga District Council is that the law is being used to support the power of local authorities to plan. It is from this power to plan that local authorities derive the power to zone. The legal decisions in support of zoning are really decisions affirming the power of local authorities to plan. Zoning is recognised merely as an instrument to achieve the objectives of the plan. Zoning exists because local authorities have the power to plan. The RMA provides for very specific powers for local authorities to plan.

However, by rewording section 104 (1) to remove the words 'shall have regard to any actual and potential effects of allowing the activity' from the original s 104(1) and their replacement in the amended s 104 (1) (a) with the addition of the words 'on the environment' after 'potential effects', and the removal in s 105 of the requirement to consider the full range of matters in s 104 when exercising discretion, the law makers have removed the interpretation that allowing an activity could affect the coherence of the plan. The decision of Batchelor v Tauranga District Council seems not what the

law makers had in mind in the original drafting of the RMA. The amendments will make it difficult for local authorities to appeal to 'the plan' when opposing future resource consents.

The Influence of Property Law in Market Arrangements

Cooter and Ulen (1988), propose that the tools of micro economic theory can be used to make economic explanations of the law and make predictions of the consequences of legal rules since 'the rules created by law establish implicit prices for different kinds of behaviour, and the consequences of those rules can be analysed as the response to those implicit prices' (op cit p11). Hirsch (1988) takes a similar view when he states that 'laws are authoritative directives that impose costs and benefits on participants in a transaction and in the process alter incentives' (op cit p1).

From a legal standpoint, property is a bundle of rights. These rights describe what a person may or may not do with the resources that person owns. Cooter and Ulen (1988) state that ownership of bundle of rights has two dimensions. First, 'the owner is free to exercise those rights', second 'others are forbidden to interfere with the owners exercise of those rights' (op cit p91). Since economic theory proposes that a Pareto improvement can be established through voluntary exchange, property rules can be analysed as to whether and how they assist the transfer of resources by facilitating private bargaining. 'Because voluntary exchange is mutually beneficial, that is, welfare enhancing, economic theory can be used to identify the obstacles to private bargaining and to demonstrate how legal rules can contribute to overcoming those obstacles.' (op cit p100). The framework for this analysis follows from what Cooter and Ulen (1988) term the 'two normative principles of property law' (op cit p101): the normative Hobbes Theorem - minimise the harm caused by private disagreements over resource use; and the normative Coase Theorem - minimise the obstacles to private agreements over resource allocation. Thus economics can be used to ask 'whether, and how, a property rule or institution lubricates the transfer of resources by facilitating private bargaining.' (op cit p102). Cooter and Ulen (1988) show in a bargaining model that bargaining proceeds by identifying the threat points of the parties, then determining the cooperative solution, then finding a reasonable way to divide the surplus from cooperation. Obstacles to cooperation can be identified from this process: uncertainty about the threat points, the existence of high costs of identifying and enforcing the cooperative solution, and when one or both parties act unreasonably about dividing the surplus.

The two normative principles of property law suggest that property law ought to facilitate private agreements by reducing these costs.

The Relevance of the Coase Theorem

According to an argument advanced by Coase (1960), adequate assessment of all the social costs associated with externalities requires recognition that two parties are always involved in an externality situation.

"A question is often thought of as one in which A inflicts harm on B and what has to be decided is: how should we restrain A? But this is wrong. We are dealing with a problem of a reciprocal nature. To avoid the harm to B would inflict harm on A. The real question that has to be decided is: should A be allowed to harm B or should B be allowed to harm A? The problem is to avoid the more serious harm" (Coase *ibid* pp 1-2).

For social policy, the fundamental issue reduces to the notion that at any point in time, there is a legally sanctioned structure of property rights in existence. If the prevailing structure is to be modified by social action designed to reduce or eliminate the effects of an externality, taxes must be imposed on those who will gain from the proposed legal change and compensation paid to those who will suffer capital loss or loss of satisfaction as a result of the new law (Sherman (1969).

Coase (1960) also showed that, in the absence of transaction costs, the composition of output in an economy is independent of the structure of property rights - except insofar as changes in the distribution of wealth affects demand patterns. More concretely, the composition of output is said to be independent of whether or not the individual creating diseconomies bears the liability for the damages caused to others. The case turns on the fact that a cost is incurred by B when B pays an indemnity to A in order to produce another unit of output or when B foregoes a bribe by A designed to induce B to limit production. Regardless of who owns the property rights, the effect on the outcome is the same, and the outcome maximises the social value of the resource.

Fischel (1985) develops the assumptions under which the Coase theorem holds. Fischel draws upon the metaphor in property law that property is a 'bundle of sticks'. The implication is that one can split property entitlement bundles in many ways: 'private agreements to divide property can involve covenants, easements and other 'equitable servitudes' that divide an interest. Nuisance law and zoning law can also be thought of as dividing up entitlements between the public and private landowners' (*ibid* p 90).

In order for individuals to be able to exclusively enjoy the benefits of private goods, the property rights to those goods must exhibit certain characteristics. These property rights (or entitlements) have been described by Fischel (*ibid*).

- If,
- (a) entitlements that are completely defined (ie they can be measured in some way);

- (b) entitlements that are exclusively assigned so that their owners can prevent others from using them adversely to their interests;
 - (c) entitlements may be legally and costlessly transferred from one party to another so that there are no barriers to trade; and
 - (d) the initial distribution of entitlements does not in itself affect the demand for any subsequent exchange,
- self interested exchange can be depended upon to yield a unique and economically efficient allocation of resources (*ibid* pp 90-91).

The relevance of the Coase theorem therefore is the insight it gives to the role of institutions when economic exchange takes place. Of particular significance is the recognition of the role property rights have in economic exchange. Also of significance, is the recognition of the role of transaction costs; that the world is not one of resources fully priced at their marginal cost as the Pigouvian analysis assumes. Whilst the Coase theorem supports the normative notions in economic theory and property law that private exchange is allocatively efficient, it also recognises that efficient institutions are those that minimise total costs, including transaction costs, and that these institutions may not be pure market institutions.

Zoning therefore may or may not be an efficient institution to minimise total costs. Because zoning provides for only a partial assignment of rights (Fischel 1978), whether zoning is more efficient compared to other arrangements, depends on comparative transaction costs.

Ellickson (1973) provides an analysis of the transaction costs associated with zoning. Ellickson (*ibid* p688) distinguishes between three categories of transaction costs associated with land use issues. The first category is termed nuisance costs - the decrease in utility or production value of neighbouring property. These costs are what have been termed externalities above. The second category is termed prevention costs - the opportunity costs incurred by either a nuisance maker or the injured neighbour to reduce the impact of the nuisance cost. The third category is termed administrative costs - 'the public and private costs of getting information, negotiating, writing agreements and law, policing agreements and rules and arranging for the execution of preventative measures.' (*ibid* p689). Efficiency is achieved when the sum of nuisance, prevention and administrative costs are minimised. Zoning concentrates largely on minimising nuisance costs - although some effort is made to remove some administration costs. Ellickson suggests however that the reduction in nuisance costs that zoning achieves is less than the concomitant prevention and administration costs, thus 'other internalisation devices are likely to be better equipped to deal with the many problems now handled by zoning' (*ibid* p699). Nevertheless, as the Coase theorem suggests, the efficiency of zoning will vary with the type of externality at issue, depending on the nature of the transaction costs.

The Political Market

The distribution of the property rights associated with zoning are determined by the political and bureaucratic processes. Social choice theory suggests that the allocation and distribution of property rights by politicians and bureaucrats is unlikely to be equitable or efficient.

Free markets and free governments imply that individuals are allowed to express their preferences freely, efficiently and without coercion. People living in a capitalist economy express their preferences for the provision and allocation of private goods through their willingness to pay in the private market. Those living in a democracy, express their preferences for the provision and allocation of public goods by casting their political votes in the ballot box.

Collectively, the right to vote is extremely valuable, but 'the value of the entire populace electing a government or making decisions on public issues should not be confused with the value of the voting right to the individual.' (Johnson (1991) p134). The right to vote has little operational value to the individual, because a single individual has little probability of affecting the outcome of any election.

Rational abstention from voting is damaging to the theory of democratic self rule. The foundations of the democratic decision making structure, based on individuals reflecting their preferences about candidates and issues, is destroyed. The individual is at the mercy of a political decision making process over which the individual has no control. The political outcome will always be the same, whether an individual places a high or low value on the outcome, and whether the individual votes or not. Through rational abstention, the preferences of non voters are not reflected in the outcome. Thus if a political candidate is elected by one half of the fifty percent who voted, only twenty five percent of the citizens have affirmed their support for the candidate. It is thus difficult to interpret this as the consent of the governed. It is also probable that those who do vote do not constitute a random selection of the population. The voting outcome will then reflect not the will of the majority, but the preferences of those who, for some reason, actually went to the polls.

Even assuming that people do vote and that they do obtain information about public issues, Wicksell (1967) showed that simple majority voting can result in the majority passing expenditure bills to benefit themselves while placing the tax burden on the minority and in doing so waste resources. If the political system is to replace the market system it is important to find an efficient means of transferring the preferences of individual citizens into a single collective preference. The paradox of voting shows that even if individuals have stable preferences, simple majority voting does not result in such a stable ordering.

Black (1948) first identified the voting paradox, but Arrow (1958), formalised and popularised it into the General Possibility Theorem. The General Possibility Theorem generalises the voting paradox by proposing that the paradox is possible in any fair system of amalgamating preferences. Thus in any democratic institution, members of society can expect that some of their social choices will be unordered or inconsistent, and when this is true, no meaningful choice can be made as it is not possible to say whether choice x or y is best or right or most desired.

The possibility of a lack of meaning in the outcome of voting is a serious problem for social judgment and social choice. Some doubt must be placed on the content of any 'social welfare' or 'public interest' that are discovered by amalgamating individual value judgments. The practical consequences for social choice can be worse however. The practical consequences are either that power is concentrated in society in order to guarantee on ordering or consistent path, or that any system of voting can be manipulated to produce outcomes advantageous to the manipulators. Assuming that society discourages the concentration of power, two methods of manipulation are always available, no matter what method of voting is used. First, those in control of procedures can manipulate the agenda (eg by restricting alternatives or by arranging the order in which they are brought up). Second, those not in control can still manipulate outcomes, by false revelations of values - strategic voting.

Various social choice theorists (Gibbard (1973), Satterthwaite (1975), Gardenfors (1977)) have shown that the possibility of strategic voting is an inherent feature of voting methods. Given any profile of preferences, any voting method can be manipulated. That is, 'assuming there are 'true' preference orders for voters, then there are occasions on which some voters can achieve a desired outcome by voting contrary to their true preferences' (Riker op cit p141).

In the discussion so far, it was implicitly assumed that alternatives were discrete objects. Although it is true that political alternatives often appear discrete, social choice usually thinks of them as continuous. Black's (op cit) original idea that alternatives could be expressed as curves in two dimensional space, implies that alternatives are continuous variables. Arrow (op cit) in his interpretation of alternatives as "social states" also implies continuous alternatives.

The spatial model of party competition, reinforces this belief in the continuity of alternatives. In Down's model (1956) with only one dimension of judgment, voters' ideal points are arranged on an ideological scale and parties are shown to write platforms located on the median point of the scale. In reality, there are many dimensions of judgment. Continuity in a world of several dimensions is important for strategic manipulation, as it allows for the easy multiplication of alternatives. This generates a wide variety of individual orderings with the consequence that the chance of a social choice reducing

to practically zero. The prospect of any kind of political equilibrium does not thus exist. Riker (op cit) recognises that the hope of identifying a political equilibrium dies hard because it is a failure both scientifically and philosophically. Riker's conclusion is that 'the wisest course for a science of politics is to abandon the search for equilibria and try to understand what the world is without them' (op cit p198).

The Bureaucracy

Weber (1947) stressed the idealised operation of a bureaucracy in a democracy. Weber maintained that the bureaucratisation of the political and economic spheres of society was the most significant development in the modernisation of western civilisation. Weber assumed that voters are knowledgeable and public spirited individuals who make meaningful decisions on policies by electing politicians to office. These political representatives pass legislation that is clear and unambiguous, and then bureaucrats administer the laws. Bureaucrats are assumed to be knowledgeable, talented and interested only in the administration of policies without implementing their own policies of pursuing their own objectives.

The economic literature on bureaucracy reflects the everyday views of bureaucracy. Officials and civil servants are basically portrayed as wanting to maximise their budgets, within external constraints. Two key public choice works which form the focus of this view are Downs (1967) and Niskanen (1971, 1973).

Bureaucrats' Motivations

Bureaucrats are officials working permanently for large organisations in circumstances where their own contribution to organisational effectiveness cannot be directly evaluated, (Downs, op cit pp24-25). Bureaucrats play the same supply side role as entrepreneurs or managers in the theory of the firm. Downs makes role specific assumptions about bureaucrat's preferences. In their public as well as their private roles, bureaucrats are rational, utility maximisers, optimising benefits net of costs. 'Every official acts at least partly in his own self interest, and some officials are motivated solely by their own self interest'. (ibid p83).

Instrumental motivations in bureaucrat's behaviour show up in four key biases running through all aspects of agency operations. (ibid pp77-78). First, officials always distort information communicated upwards to superiors or politicians so as to present their own or their sections activities in the most favourable light. Second, officials always respond to decisions by their superiors or politicians in a discretionary way, implementing decisions consistent with their own self interest more speedily, and de-emphasising

those which are inconsistent. Third, in choosing between broadly equivalent policies, officials always choose outcomes advantageous to their interests. Finally, officials 'search' behaviour for new policy solutions is heavily influenced by self interest (Dunleavy (1991, p149).

To analyse how parts of agencies or whole bureaus behave, these micro level propositions are simply scaled up. Every section in an organisation is in partial competition for more funding, staffing, policy territory or other resources (Downs op cit p53). A similar picture applies to whole agencies: 'Every large organisation is in partial conflict with every other social agent it deals with (ibid, p216); 'bureaus tend to invest excessive resources in territorial struggles that is more than they would if officials had no biases' (ibid p216); bureaus tend to be inertial, 'to continue to do today what they did yesterday' (ibid p195), as a result of sizeable sunk costs, consisting of past investment in plant and staffing, standard operating procedures, and modes of relating to clients, politicians and the rest of society.

Like other organisations, bureaus have inherent tendencies to expand, but fewer than normal constraints on their ability to do so (ibid p17). Agency growth helps retain and upgrade personnel; enables leaders to obtain more power, income and prestige; reduces internal conflicts; facilitates economies of scale; helps insulate top officials from change and strengthens the agencies ability to survive.

ALTERNATIVES TO ZONING: A LEGAL APPROACH

The implications of the preceding analyses are that, where transaction costs allow, it is both more efficient and fair to resort to market measures rather than political measures such as zoning to resolve resource use issues. Market measures propose that a Pareto improvement can be established through voluntary exchange. Property rules ought then to facilitate the transfer of resources by facilitating private bargaining. Facilitation of private bargaining can be achieved by a set of legal rules than minimise the costs that provide obstacles to private cooperation.

Covenants, Mergers and Other Consensual Systems

Following Ellickson (1973), consensual systems of internalising - the merger of adjoining land parcels and covenants between their owners - are efficient and fair mechanisms for handling external costs, particularly in areas where much of the land is still undeveloped, as administration costs are low.

In most locations, the wish of neighbours to show good manners, essentially a consensual system, operates to limit the incidence of nuisances. If land use

control was a laissez faire distribution of property rights, the lack of good manners would result in external costs being imposed on others. In such a system, landowners would be expected to try two types of voluntary transactions, merger and the partial exchange of rights. A merger is effected when a landowner is prompted to buy neighbouring land. If there were no financing problems, this outcome is likely where the administration costs of acquisition and unilateral rule making are less than the costs of bargaining for and enforcing a more limited exchange of rights. Such exchange is therefore efficient.

The neighbouring owners may decide not to merge, but rather negotiate a lesser exchange of rights. For some consideration, a landowner might submit to restrictions on the use of land or agree to be bound by affirmative obligations to carry out specific obligations. Existing property law provides for enforcement of many agreements of this type, including covenants, leases, easements and defeasible fees.

Covenants represent the most prevalent type of agreement between neighbours. Covenants negotiated between landowners will tend to optimise resource allocation among neighbours. In other words 'the reduction in future nuisance costs to each party will exceed the sum of the prevention and administration costs each agrees to bear, with all costs discounted to present value' (ibid p713). For example when a developer of a subdivision drafts covenants that will bind people who move into the development, market forces will prompt the developer to draft efficient covenants. Covenants will only enhance the developer's profit if they increase the developer's land values by more than the cost of imposing them. The developer's land values will only rise if homeowners perceive that the covenants will reduce the nuisance costs they might suffer by an amount greater than the sum of their loss of flexibility in use and future administration costs.

Ellickson (ibid) suggests a number of steps can be made to reduce the administration costs of covenants, thus encourage their greater use. Standard forms could reduce drafting costs to parties and information costs to participants in land markets, compared to deciphering zoning restrictions. Information costs could be reduced by modernising the indexing of land records. More definite exposition of termination doctrines might also reduce administration costs. Methods of enforcing covenants could be improved, perhaps by municipal enforcement of private covenants. Much information on reducing the administration costs of covenants could be learnt from analysing existing covenants, for instance those covenants that exist in retirement villages like Allandale.

Covenants could play only a limited role in older, more established suburbs where land ownership is highly fractionated. 'Except for the simplest problems involving only a few neighbours, land owners rarely meet as a group to draft agreements governing land use... the costs of organising many people are apparently too high, and the risk of freeloaders too great, for private bargaining to take place' (ibid p718).

Reforming Nuisance Law

Where consensual systems are not possible, more coercive devices to discourage unneighbourly behaviour may be needed. Ellickson (ibid) suggests that in this situation, coercion can be achieved through an efficient and fair set of nuisance rules. Substantial injuries from nuisances can be internalised through private lawsuits by the injured neighbours. A plaintiff entitled to a remedy would be able to choose between collecting damages and purchasing the termination of the nuisance at the objective cost of that termination to the nuisance maker.

The use of nuisance law realigns property rights and can be more efficient and fair because it places a risk of loss from external harms on the landowner carrying out the damaging activity. Common law doctrines have long assigned property rights to deter unneighbourly acts. As Ellickson (ibid) states 'invasions by persons, animals, or solid matter capable of inflicting injury through the force of physical impact are actionable under trespass doctrines. The famous case of *Rylands v. Fletcher* imposed absolute liability for damage caused by the overflow of unnaturally occurring substances onto neighbouring land. Less tangible interferences such as noise, fumes, aesthetic blight, or vibration may be handled under the law of nuisance' (p717).

The traditional remedy in nuisance cases has been injunctive relief. An injunction often imposes prevention costs and administration costs that far exceed the reduction in nuisance costs it achieves. Recognising this, 'courts have tried to limit the circumstances in which they were willing to find a nuisance... thus came to provide no relief in many cases where the risk of loss should appropriately have been shifted to the landowner carrying out the damaging activity' (ibid p720). Nuisance law has thus been widely viewed as an archaic means of handling land use problems. Zoning, by regulating nuisance, was seen as a more efficient method of dealing with land use problems.

Calabresi and Melamed (1972) observed that there are four possible rules on remedies in nuisance cases. Under the first rule, the plaintiff is entitled to enjoin the defendant's nuisances. This is the traditional relief. Second, the plaintiff is entitled to damages from the defendant but not to injunctive relief. The third rule is that the plaintiff may neither enjoin the defendant's conduct nor collect damages. The fourth rule, permits the plaintiff to enjoin the defendant's conduct, but only if the plaintiff compensates the defendant for the defendant's losses caused by the injunction.

According to Ellickson (ibid), 'nuisance law would function much better if, in general, a plaintiff in a nuisance case were limited to choosing between the remedies of rule two (damages) and rule four (compensated injunction)' (p738). Rules one and three remain essential in unusual situations in order to protect the fundamental rights of one of the parties.

The danger of injunctive relief, as discussed, is that the cost to the defendant of an injunction might exceed its benefits to the plaintiff, and that, because of high administrative costs, the parties will be unable to bargain for a modification of the overly strict court decree. Courts generally recognise this danger and try to balance the utility of the defendant's activity against the amount of damage it does, before granting injunctive relief. The balancing exercises are expensive and introduce uncertainty into the conflict resolution process. The courts are often forced into this balancing chore in nuisance litigation because there is nothing to deter a plaintiff from seeking an inefficient injunction.

In contrast, rules two and four are less likely to be inefficient remedies. Rule two internalises the nuisance and permits the defendant to conduct a personal cost - benefit of preventative measures. By shifting the cost of an injunction back to the plaintiff, rule four discourages plaintiffs from seeking inefficient injunctive outcomes, and thus saves some of the administrative costs of rule one.

The analysis of Calabresi and Melamed (ibid), leads Ellickson (op cit) to conclude that nuisance law be reformed to allow the plaintiff to invoke either rule one or rule four remedies, as in most instances (other than when essential liberties need protecting), these allow a more efficient outcome. These remedies are likely to be more efficient because they minimise the sum of nuisance costs, prevention costs and administrative costs arising from land use conflicts.

Fines and Uniform Mandatory Standards

A pervasive nuisance may inflict substantial harm on nearby neighbours and also legally insubstantial injuries to a large number of more distant parties. Entitlement to nuisance remedies assures those suffering large injuries compensation for their losses. Use of nuisance remedies to internalise insubstantial pervasive harms, however would pose very high administration costs. Fines, regulatory taxes, mandatory standards and mandatory prohibitions, may prove to be more efficient intervention by eliminating the task of assessing and distributing small awards. An informed choice among these more collective systems for internalising nuisance would primarily be based on empirical examination of each system's relative administration costs and potential for allocative damage.

CONCLUSION

The analysis of the Resource Management Act 1991 and its 1993 amendments, indicated that, although local authorities and the courts were ideologically inclined towards using zoning as a tool to control the effects of development, zoning is not a prerequisite to achieve the purpose of the Act.

Under s32 zoning has to be shown to result in a more efficient outcome than other methods of development controls (if any).

Normative economic and property theory suggested that efficient outcomes are a logical outcome of market exchange, and property law ought to remove the obstacles to private exchange or bargaining. The Coase theorem provided an analytical framework to identify the obstacles to private exchange, emphasising the role of property entitlements and transaction costs in institutional arrangements affecting exchange. The pertinent goal for efficient resource use was expressed as the minimisation of the sum of nuisance, prevention and administration costs.

The political market developed rested on the general theorem that individuals political behaviour are motivated by self-interest. The outcome of rational voter behaviour reflects the preferences of those who for some reason actually voted. Voters vote for those candidates who favour policies that would most enrich the voter. The lack of meaning of the outcome of voting meant that the 'public interest' could be defined to be anything that politicians, and those who were motivated to influence politicians, chose. Elected and non elected officials are power maximisers, exclusively concerned with winning re-election or enhancing the power of their bureau. Thus the attitudes of both voters and officials towards urban development policies are determined primarily by the distributional effects of these policies rather than the efficiency effects of these policies. The feature of local government is that all home and business owners are eligible to vote. Residents who do vote are motivated to elect officials who would enhance the distribution of benefits of development control in their favour. Hence the popularity of zoning controls. In contrast, the costs of 'anti-development' measures fall on people who lack or do not exercise the local franchise.

It was also argued that because of the voting paradox, a transitive ordering of social preferences was impossible to achieve.

Reforms that minimise the transactions cost of private exchange were suggested. These included consensual systems of internalising through mergers or covenants. Where consensual systems were not possible, reforms to the common law of nuisance entitling the plaintiff to elect damages or compensated injunction, rather than the traditional relief of injunction, were suggested. These reforms to nuisance law will enable a more efficient outcome as they minimise the transaction costs of land use conflicts.

Whether the reforms suggested are more efficient than zoning, when all transaction costs are taken into account, remains an empirical matter. Suggestions for further research in this area include: empirical work on the allocative and distributional impacts of alternative internalisation systems; better understanding of the political economy of local body politics and the legal system.

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MULTI-LEVEL MODELLING OF NATURAL RESOURCE POLICY: AN APPLICATION IN SOIL EROSION CONTROL

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Introduction

While the importance of topsoil and the problem of topsoil loss have long been recognized, decades of government programs in both industrialized and developing countries have made only minor improvement in the damage caused by agriculturally-based erosion. One-third of U.S. cropland topsoil has been lost in the last 200 years [Walker], and sheet and rill erosion on U.S. cropland continues at a rate of 1.5 billion metric tons annually [USDA/SCS, 1990]. Though the nature of the New Zealand problem is different than in the U.S., New Zealand also has serious erosion problems with over 8 million hectares—one-third of the country's total land area—subject to soil erosion [NZDS, 1993].

In the midst of these problems, there is a tendency for policy debate on soil erosion to focus primarily on physical actions to be taken rather than upon policy goals and objectives. Yet the use of physical goals of soil loss is often challenged by economists who argue that it is not the physical loss from the farm that is important, but the costs incurred by loss of topsoil, and offsite damages from agriculturally-generated sedimentation [Robinson]. Kenneth Robinson states "a shift away from emphasizing physical targets to the use of economic criteria (or some combination of the two) probably would lead to greater returns to society from the dollars currently invested in conservation activities."

Also, soil erosion policy frequently is focused on onsite productivity impacts of soil erosion, while offsite sediment damages may well be greater [McConnell; Swanson, 1979]. Sediment is a major polluter of ponds, streams, rivers and reservoirs. Sediment trapped in ditches and lakes reduces water holding capacity and increases the likelihood of flooding. It increases dredging costs of rivers and harbors, fills reservoirs, damages wildlife habitats and diminishes recreational enjoyment of water resources. The annual offsite cost of erosion in the United States is estimated to be NZ\$10.7 billion¹ (US\$6.2 billion) [Clark, et al.]. The authors found no comparable estimate for offsite damages in New Zealand.

This paper examines a policy model intended to combine economic and physical relationships in soil erosion control, demonstrates the application of the model to a highly-erodible region of western Tennessee in the United States, and tries to draw some conclusions from the exercise which are relevant to New Zealand. The model, an adaptation of the multi-level programming model developed by Candler and Norton and extended by Sylvia and Anderson, is a multi-level optimal control model in a single state and single control.

The producer's dynamic problem is optimised in the first stage, then the producer's optimal decision paths are used in the second stage as components of the policymakers' dynamic problem. The second stage problem utilizes weights indicating the relative importance of the policymaker's competing goals. Those weights are used to construct a dynamic policy frontier demonstrating the relationships between policy goals and the resulting optimal solutions. Extensions of this model, in multiple states and controls may be more appropriate for empirical application, but this model is intended to allow an analytical solution and explore the resulting added insights.

The Theoretical Model

A basic premise underlying the model is that several specific elements are necessary for the development of a soil erosion policy model. Those elements include modeling (1) the interaction of producer and policymaker [Anderson and Lee; Candler, et al.; Candler and Norton; Sharp and Bromley; Sylvia and Anderson], (2) the dynamic nature of the sedimentation process [Ervin, et al.; Rausser, 1980; Swanson, 1982], and (3) the recognition of multiple, competing goals of the

¹ The study was conducted in U.S. dollars. Conversion to New Zealand dollars is assumed at an exchange rate of US\$1.00=NZ\$1.72.

polycymaker [Rausser and Yassour; Sylvia and Anderson; Van Kooten, et al.]. Previous erosion models have addressed one or two of these elements, but not all three.

The Producer's Dynamic Model

The farmer produces crops and erosion as he seeks to maximize the time stream of discounted profits. The erosion results from tillage of the soil for planting and from harvesting. Erosion production is measured as some multiple of production and the eroded soil is eliminated through runoff into streams and ditches carried by rain. The erosion affects the productivity of the farm production and negatively impacts waterways downstream as sediment. While potential instruments for controlling erosion by the farmer might include controls such as tillage practices, site placement, and field size and slope, it is assumed that such factors are fixed and that the only existing instrument is production. Variations in the other factors are assumed to be accounted for in the cost equation. The only instrument available to the polycymaker to affect the farmer's decisions is a per unit tax² on erosion. The "producer" in this model is assumed to be a homogeneous aggregation of all individual producers within the producing area.

The producer's formal problem is:

$$(1) \quad \text{Maximize} \quad \int_{t=0}^{T=\infty} e^{-rt} [pY(t) - C(Y(t)) - \tau E(t)] dt$$

$$(2) \quad \text{subject to:} \quad \dot{E} = F(E(t), Y(t)),$$

and the usual set of non-negativity and convexity conditions, where: p is the revenue per unit of production, Y is the number of units produced, C is a convex production cost function, λ is a per unit erosion tax, E is the erosion stock, t is time, r is the private instantaneous annual rate of discount, and F represents the erosion state equation.

Using an optimal control framework, the current-value Hamiltonian is:

$$(3) \quad H^c = [pY(t) - C(Y(t)) - \tau E(t)] + \lambda F(E(t), Y(t))$$

The necessary conditions are:

$$(4) \quad \frac{\partial H}{\partial Y} = (p - C'(Y)) + \lambda F'(Y) = 0 \quad (\text{optimality condition})$$

$$(5) \quad -\frac{\partial H}{\partial E} = \dot{\lambda} - r\lambda = \tau - \lambda F'(E) \quad (\text{adjoint equation})$$

$$(6) \quad \frac{\partial H}{\partial \lambda} = F(E, Y) = \dot{E} \quad (\text{equation of motion}).$$

The optimality condition indicates that the short-run profits must just equal the incremental erosion costs to the farmer. The adjoint equation relates the change in the marginal cost of erosion to the tax rate, the private rate of discount, and the erosion stock. The equation of motion indicates that the physical/economic optimum must equate the production and natural decay of erosion. It is implicitly assumed that the transversality and complementary slackness conditions hold as follows: $\lambda(T) \geq 0$ and $\lambda(T)E(T) = 0$.

The state equation, showing the change in the erosion stock over time, is assumed to be represented by the explicit equation:

$$(7) \quad F(E(t), Y(t)) = \dot{E} = -hE(t) + kY(t), \quad \text{subject to: } 0 < h, k < 1,$$

² While the debate over the use of taxation as a policy instrument is important, the relative merits of either argument need not be determined to accept the usefulness of a tax-based model. The optimal tax level developed in this study could conceivably be used as the basis for a tax-based policy, yet the economic information derived from such an analysis is valuable in its own right. The optimal tax level is an economic measure of the level of externality imposed upon society by agricultural production. This optimal tax, if not imposed, may be thought of as an involuntary transfer from society as a whole to the agricultural industry.

where h is the coefficient of decay of the erosion stock and k is the erosion production coefficient. Thus, the net change in erosion stock in a given period is the erosion generated from production less the eroded soil carried out of the study area by the action of wind or water.

The producer's cost function is assumed to take the form:

$$(8) \quad C(Y(t)) = q + dY(t) + gY^2(t), \quad \text{subject to: } q \geq 0; d, g > 0$$

The Pontryagin conditions can be manipulated into a dynamic plane equation system of two first-order differential equations in Y and E :

$$(9) \quad \dot{Y} = Y(r+h) + \frac{(d-p)(r+h) + \tau k}{2g},$$

$$(10) \quad \dot{E} = -hE(t) + kY(t), \quad \text{subject to: } 0 < h, k < 1.$$

To evaluate the motion of this system, we must first identify those locations in which the system is stable, that is, the steady states associated with these equations. At equilibrium, the change in Y over time, $\dot{Y}$, becomes zero. Thus setting equation (9) equal to zero and solving for Y will result in the equilibrium level of output, Y^* :

$$(11) \quad Y^* = \frac{(p-d)}{2g} - \frac{\tau k}{2g(r+h)}.$$

The equation of motion (6) will also be zero at steady state. By substituting (11) into (7) and setting it equal to zero, the equilibrium erosion stock, E^* , may be found:

$$(12) \quad E^* = \frac{k}{h} Y^* = \frac{k(p-d)}{2gh} - \frac{\tau k^2}{2gh(r+h)}.$$

Since it is presumed that the system is not at equilibrium, we are particularly interested in the stability of the equilibrium and the motion that takes place elsewhere in the plane. We can determine that motion, and the nature of the steady state, with equations (7) and (9). We take the derivative of each with respect to Y , and determine the sign of the result:

$$(13) \quad \frac{\partial \dot{Y}}{\partial Y} = r+h > 0,$$

$$(14) \quad \frac{\partial \dot{E}}{\partial Y} = k > 0,$$

and plot the motion that occurs around the steady state.

The two isoclines divide the plane into four quadrants as shown in Figure 1, and the trajectories within each quadrant define a saddle-point equilibrium. In order to meet the transversality conditions, where $T=0$, the producer must approach the equilibrium at Y^* , E^* as $t \rightarrow \infty$. Since point A is a saddle-point, the only approach path is along the convergent separatrix where $\dot{Y}=0$. The producer's profit maximizing strategy is to adjust output to Y^* . Erosion stock will then either increase or decrease toward equilibrium at E^* , depending upon whether the initial condition of E is to the right or to the left of $\dot{E}=0$.

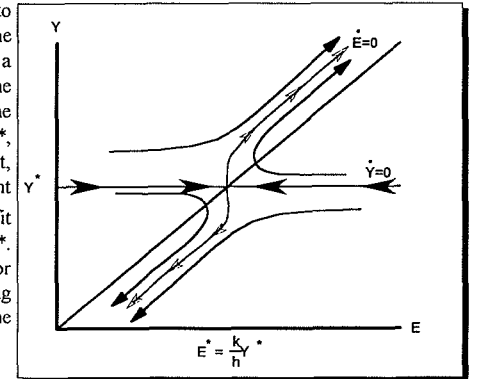


Figure 1. Phase diagram of producer's model.

The Policymaker's Dynamic Model

Once the optimal producer's behavior is determined, the policymaker's dynamic problem may be solved. Assume that the policymaker wishes to maximize the stream of discounted net revenue from agricultural production, water quality, and taxes on erosion. The producer may use the producer response information derived from the producer's model to determine the optimal tax policy. The policymaker's formal problem is:

$$(15) \quad \text{Maximize} \quad \int_{t=0}^{T=\infty} e^{\delta t} [apY(t) - b\gamma E(t) + c\tau(t)E(t)] dt,$$

$$(16) \quad \text{subject to:} \quad \dot{E} = F(E(t), Y(t))$$

$$(17) \quad \dot{Y} = G(Y(t), \tau(t))$$

$$a + b + c = 1; \quad 0 \leq a, b < 1; \quad 0 < c \leq 1;$$

and the usual set of non-negativity and convexity conditions where:

a, b, c = the relative weights the policymaker attaches to agricultural revenue, water quality, and tax revenue, respectively; G = the state equation for Y resulting from the producer's movement along the optimal path; γ = the unit cost of the erosion stock, E ; and δ = the social instantaneous annual rate of discount.

The $pY(t)$ term is the increase in the value of the objective functional due to agricultural production, $-\gamma E(t)$ is the decrease in the value of the objective functional due to erosion damages, and $\tau(t)E(t)$ is the increase in the value of the objective functional due to tax revenues.

Using the explicit form in (7) and the value of Y^* in (11) yields the Hamiltonian:

$$(18) \quad H = ap \left[\frac{p-d}{2g} - \frac{\tau k}{2g(r+h)} \right] - b\gamma E + c\tau E + \mu \left[-hE + k \left(\frac{p-d}{2g} - \frac{\tau k}{2g(r+h)} \right) \right].$$

The necessary conditions are:

$$(19) \quad \frac{\partial H}{\partial \tau} = -\frac{apk}{2g(r+h)} + cE - \frac{\mu k^2}{2g(r+h)} = 0$$

$$(20) \quad \frac{\partial H}{\partial E} = b\gamma - c\tau + \mu h = \dot{\mu} - \delta\mu$$

$$(21) \quad \frac{\partial H}{\partial \mu} = \dot{E} = -hE + k \left[\frac{p-d}{2g} - \frac{\tau k}{2g(r+h)} \right].$$

An examination of the Hamiltonian demonstrates that the system is linear in the control. Thus, by Miller, the solution is of the "bang-bang" type and the following tax rates derived from (19) would prove optimal:

$$\begin{aligned} &> \frac{\mu k^2}{2g(r+h)} \text{ then } \tau^{\min} \\ \text{If } \frac{apk}{2g(r+h)} - cE &= \frac{\mu k^2}{2g(r+h)} \text{ then } \tau^* \\ &< \frac{\mu k^2}{2g(r+h)} \text{ then } \tau^{\max} \end{aligned}$$

The interpretation of this solution is straightforward. $\frac{apk}{2g(r+h)}$ is the amount by which agricultural revenues are decreased in the current period, cE is the amount by which tax revenues are increased in the current period, and $\frac{\mu k^2}{2g(r+h)}$ is the amount by which the discounted stream of future erosion damage decreases, all when the tax rate is increased by one unit. Thus, when $\frac{apk}{2g(r+h)} - cE > \frac{\mu k^2}{2g(r+h)}$, the value of agricultural production and tax revenue is more valuable to the policymaker than the cost of erosion damage resulting from production. Given this, the policymaker wants to increase production to Y^* and he implements tax rate $\tau^{\min}$. When $\frac{apk}{2g(r+h)} - cE < \frac{\mu k^2}{2g(r+h)}$, the policymaker values clean water more highly than current production and he implements tax rate $\tau^{\max}$ to decrease agricultural erosion.

In a manner similar to that of the producer problem, the Pontryagin conditions can be manipulated to yield the optimal tax rate, τ^* :

$$(22) \quad \tau^* = \frac{(h+\delta)(p-d)(r+h)}{k(2h+\delta)} - \frac{aph(h+\delta)}{kc(2h+\delta)} + \frac{b\gamma h}{c(2h+\delta)}.$$

The optimal tax rate equation can be thought of as a tax response function of the policymaker's, or society's, values of agricultural production versus water quality. A greater value placed on agricultural revenues (a) by the policymaker results in a lower equilibrium tax rate. Conversely, a greater value placed on water quality (b) results in a higher equilibrium tax rate. The relationship between the value for tax revenues (c) and the tax rate, however, depends upon the elasticity of the tax revenue supply curve which is determined by the relative values of h and k [Sylvia and Anderson].

The Empirical Model

The model was applied to a three-county region in West Tennessee consisting of Obion, Weakley, and Gibson counties (Figure 2). These three counties are located in the area categorized by the Soil Conservation Service as Major Land Resource Area 134 [USDA/SCS, 1981]. With elevations ranging from twenty-five to one hundred meters [USDA/SCS, 1981], this region lies between the Mississippi bottomlands and the Cumberland Plateau.

The majority of the land in the area is used for agriculture, with corn, soybeans and wheat being the primary crops. These three commodities represent over seventy percent of the agricultural production of the area [Mundy and Gray]. Agricultural practices and production enterprises are consistent throughout the three counties [Mundy and Gray], as are the hydrological characteristics [Water Resources Council]. Precipitation is abundant in the area, averaging about 1,270mm per year, and yields of major crops are above state averages [Mundy and Gray].

There are twelve primary soil types in the watershed. The soils are mainly from deep or moderately deep loess with the three most common soil types accounting for more than fifty percent of the total land area. The region is subject to the highest average soil erosion rates in the United States [Moore and Klaine].

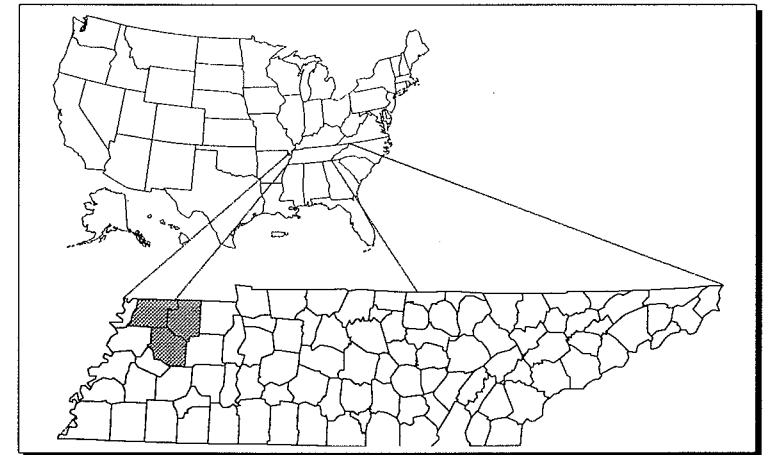


Figure 2. Map of study area.

Economic Coefficients

As the application being discussed in this paper took place in the United States, American measurement units are used instead of their international metric equivalents. The economic data required to apply the model include the cost equation, the commodity price, the unit cost of offsite sediment damages and the private and social discount rates. The producer's cost equation was not directly available, so a linear programming/linear regression model was developed to estimate these equations. Each of the twelve soil types was associated with a cost of production and a yield potential. The model selected those combinations which meet the exogenously specified revenue constraint at the least cost.

Once developed, the basic model was run multiple times using an increasing revenue requirement. The resulting minimum cost levels were then associated with the corresponding levels of output, through linear regression, to obtain continuous equations representing the relationship between cost and output. All coefficients derived from the regression were significant at a .95 or .90 level of confidence, except the quadratic term of the conservation tillage wheat model. The model was run for each major commodity in the area—corn, soybeans and wheat—assuming homogeneous production of the commodity being modeled in each run.

One problem involved in modeling an entire watershed is the variation in tillage practices. Practices vary from one farmer to another and over time. To account for this while still maintaining a parsimonious model, each commodity model was run under two different tillage conditions, conventional tillage and conservation tillage. This created a bound on the results and allowed for an analysis of the sensitivity of the results to tillage practices.

Six models resulted from the system explained above and are referred to in this study as the primary model configurations. Specifically, the primary model configurations are: conventional tillage corn; conservation tillage corn; conventional tillage soybeans; conservation tillage soybeans; conventional tillage wheat; and conservation tillage wheat.

The proxy used in the study for the real social instantaneous annual rate of discount was the nominal rate on AAA corporate bonds for June 1987 less the percentage change in price from June 1986-1987 [Federal Reserve Board]. This rate, $\delta = 0.05$, is assumed to be a good average of the productivity of low-risk investments in the capital markets. The assumed private instantaneous annual rate of discount was based upon the annual long-term fixed deposit rates offered by commercial banks in the area. The private discount rate of $r = 0.10$ was the median of rates quoted by several banks operating in Memphis, Tennessee.

The unit cost of offsite sediment damages was drawn from Alexander and English which identified offsite sediment damage costs for river basins across the United States. In that paper, an interregional sedimentation model was used to estimate the impact of the Conservation Reserve Program on sedimentation and on the offsite costs of sediment damage. The offsite erosion damage costs reported by Clark, et al. were combined with the erosion levels reported in the 1982 National Resources Inventory (NRI) to provide a base from which cost per ton estimates were generated. The unit cost of offsite sediment damages for this area was estimated to be \$6.38 (NZ\$11.00) per ton³.

The price of each commodity was obtained from Tennessee Agriculture, 1990 [Tennessee Department of Agriculture], reflecting 1988 values. The 1988 values were used to maintain consistency with the cost figures. The prices used were: \$2.75 (NZ\$4.74) per bushel for corn, \$7.65 (NZ\$13.19) per bushel for soybeans, and \$3.40 (NZ\$5.86) per bushel for wheat.

Physical Coefficients

The physical data required were the coefficients of the equation of motion: the sediment growth coefficient and the sediment decay coefficient. The sediment growth coefficient was developed using the Erosion Productivity Impact Calculator (EPIC), a plant growth/erosion simulator.

Seventy-two runs of the EPIC model were performed, incorporating every combination of the primary model configurations with each of the twelve soil types. The production practices used were

the same as those used to develop the production cost values in the linear programming models. A fifty year simulation was run and the average annual erosion was extracted for each of the seventy-two models. This resulted in twelve erosion levels for each primary model configuration. A weighted average of these 12 values was calculated, based upon the relative percentages of soil types. Since the model is based upon the erosion that reaches the water as sediment, not raw erosion, these six erosion levels were multiplied by the threshold sediment delivery ratio for the watershed. The threshold sediment delivery ratio is defined as that proportion of average annual total erosion which is delivered to a significant stream [Alexander and English]. "A 'significant' stream begins where flow becomes adequate for a beneficial use such as a municipal water supply, water-based recreation, a fishery, or domestic use."⁴

The sediment decay coefficient is much more difficult to estimate than the sediment growth coefficient. A literature search revealed no studies in which sediment movement as defined in this model have been measured. Discussions with soil scientists⁵ served largely to confirm the difficulty in estimating such a figure. Some generalizations can be made, however. One is that sediment decay as described in this model can be expected to be extremely slow. Further, the level of sediment decay will be very minor as compared with new sediment contained in both agricultural and non-agricultural runoff. While this decay may conservatively be expected to vary between 0 and 25 percent annually, depending upon the specific hydrology of an area, most values will fall in the lower extreme of the range. An estimate of .01 was selected for this coefficient. While somewhat arbitrary, this estimate is consistent with the best available knowledge. The coefficients used in the model are shown in Table 1 below.

Table 1. Model coefficient values.

Coefficient	Units	Corn		Soybeans		Wheat	
		Conventional	Conservation	Conventional	Conservation	Conventional	Conservation
Linear Cost (d)	\$/bu	1.14	1.24	2.62	2.85	2.84	3.21
Quadratic Cost (g)	\$/bu	4.7×10^{-9}	5.5×10^{-9}	3.1×10^{-8}	3.6×10^{-8}	8.8×10^{-9}	5.7×10^{-9}
Price (p)	\$/bu	2.75	2.75	7.65	7.65	3.40	3.40
Private Discount Rate (r)	\$/	0.1	0.1	0.1	0.1	0.1	0.1
Social Discount Rate (δ)	\$/	0.05	0.05	0.05	0.05	0.05	0.05
Unit Cost of Sediment (γ)	\$/ton	6.38	6.38	6.38	6.38	6.38	6.38
Sediment Decay (h)	ton/ton	0.01	0.01	0.01	0.01	0.01	0.01
Sediment Growth (k)	ton/bu	.0583	.0488	.1926	.1522	.0519	.0376
Average Erosion (ζ)	ton/ac	20.06	16.09	21.20	16.68	7.33	5.34
Average Yield (β)	bu/ac	130.50	115.35	38.51	38.36	49.45	49.80

Optimal Dynamic Strategies

The Optimal Tax Function

Substituting the coefficients from Table 1 into equation (22) yields the following optimal tax functions in terms of a , b , and c :

⁴ From an unpublished Soil Conservation Service memorandum from C. Don Clark, National Sedimentation Geologist, dated December 14, 1989.

⁵ Personal communication with Dr. Don Myer, USDA National Sedimentation Laboratory, Oxford, Mississippi, 1991.

³ All tons are short tons.

$$\begin{aligned}
 (23) \quad \tau^* &= 2.604 - \frac{.404a}{c} + \frac{.911b}{c} && \text{Conventional Corn;} \\
 (24) \quad \tau^* &= 2.917 - \frac{.483a}{c} + \frac{.911b}{c} && \text{Conservation Corn;} \\
 (25) \quad \tau^* &= 2.462 - \frac{.340a}{c} + \frac{.911b}{c} && \text{Conventional Soybeans;} \\
 (26) \quad \tau^* &= 2.974 - \frac{.431a}{c} + \frac{.911b}{c} && \text{Conservation Soybeans;} \\
 (27) \quad \tau^* &= 1.017 - \frac{.562a}{c} + \frac{.911b}{c} && \text{Conventional Wheat;} \\
 (28) \quad \tau^* &= 0.467 - \frac{.775a}{c} + \frac{.911b}{c} && \text{Conservation Wheat.}
 \end{aligned}$$

There is no a priori determination of unique values for a , b , and c . Rather, these variables represent the range of relative weights that society can place on the different benefits represented in the model. As indicated following equation (17), these values are restricted such that $a+b+c=1$; $0 \leq a, b < 1$; $0 < c \leq 1$. It was assumed for the empirical analysis that tax revenue (c) is not the primary purpose of such a policy and is not of primary concern to society relative to agricultural production and environmental quality. However, it is also clear from equations (23) through (28) that the value of c cannot be zero. Thus the value of c was initially held to .1.

Table 2 shows the value of τ^* for each primary model configuration. With c assumed to have a value of .1, the values of a and b can each vary between 0 and .9. Since both agricultural production and environmental quality, in some amount, are necessary for survival, the case in which either a or b are zero was omitted and the coefficients were allowed to vary between .1 and .8. The actual value of such coefficients is not likely to approach either extreme due to the importance to society of both commodities. In several cases, the value of the optimal tax became negative as the weights moved toward favoring agriculture, indicating that a subsidy to agriculture may be the optimal path for society.

Table 2. Optimal tax values by primary model configuration and level of social importance.

a/b (c=.1)	Corn Conventional	Corn Conservation	Soybeans Conventional	Soybeans Conservation	Wheat Conventional	Wheat Conservation
	dollars per ton					
.1/.8	9.49	9.73	9.41	9.83	7.75	6.99
.2/.7	8.18	8.33	8.16	8.49	6.27	5.31
.3/.6	6.86	6.94	6.91	7.15	4.80	3.62
.4/.5	5.54	5.54	5.66	5.81	3.33	1.93
.5/.4	4.23	4.15	4.41	4.47	1.86	0.25
.6/.3	2.91	2.75	3.15	3.12	0.38	(1.44)
.7/.2	1.6	1.36	1.90	1.78	(1.09)	(3.13)
.8/.1	0.28	(0.04)	0.65	0.44	(2.56)	(4.81)

These optimal tax values may be thought of as the value of externalities imposed upon society, weighted by the value society places on the competing goods of agricultural production and environmental quality.

Some clues to the effect on the optimal tax of a change from conventional tillage to conservation tillage planting are provided in Table 2. When society values the environment significantly higher than agriculture, the change in the optimal tax for conventional relative to conservation tillage is much smaller than when agriculture is weighted more favorably. In effect, the conservation tillage scenarios are always more sensitive to changes in a and b than the conventional scenarios. Excepting wheat, however, the optimal tax values tend to converge with the values of a and b , giving similar results near the middle of the range. As shown in the Optimal Production Function section, the physical

processes constrain the problem to these mid-range values such that the difference between tillage practices is insignificant to the problem as a whole, at least in this specific empirical application.

The Optimal Production Function

Substituting the coefficients from Table 1 and the optimal tax levels arising from equations (23) through (28) into equation (11) yields the optimal production functions facing the producers in this area:

$$\begin{aligned}
 (29) \quad Y &= 1.713 \times 10^8 - 5.638 \times 10^7 \tau && \text{Conventional Corn;} \\
 (30) \quad Y &= 1.373 \times 10^8 - 4.033 \times 10^7 \tau && \text{Conservation Corn;} \\
 (31) \quad Y &= 8.113 \times 10^7 - 2.824 \times 10^7 \tau && \text{Conventional Soybeans;} \\
 (32) \quad Y &= 6.667 \times 10^7 - 1.922 \times 10^7 \tau && \text{Conservation Soybeans;} \\
 (33) \quad Y &= 3.182 \times 10^7 - 2.681 \times 10^7 \tau && \text{Conventional Wheat;} \\
 (34) \quad Y &= 1.667 \times 10^7 - 2.998 \times 10^7 \tau && \text{Conservation Wheat.}
 \end{aligned}$$

Substituting the values of τ^* as shown in into equations (30) through (35) yields the optimal production levels for each primary model configuration by tax level (Table 3). One consideration arising from Table 3 is that, for all primary model configurations, the production level became negative as the social weights moved toward environmental quality and away from agricultural production. For each crop, there exists a tax level at which producers would no longer find it profitable to produce the commodity in question. They would either shift production to a different crop or leave agriculture altogether. The negative values in Table 3 suggest that this level of taxation is well within the range of those taxes which would otherwise be considered socially optimal. Given the profit structure of agriculture in the study area, producers of certain commodities simply cannot afford to absorb the total cost of their production externalities and remain in business.

Table 3. Optimal production levels by primary model configuration and level of social importance.

a/b (c=.1)	Corn Conventional	Corn Conservation	Soybeans Conventional	Soybeans Conservation	Wheat Conventional	Wheat Conservation
	bushels					
.1/.8	(3.64 × 10 ⁶)	(2.55 × 10 ⁶)	(1.85 × 10 ⁶)	(1.22 × 10 ⁶)	(1.76 × 10 ⁶)	(1.93 × 10 ⁶)
.2/.7	(2.90 × 10 ⁶)	(1.99 × 10 ⁶)	(1.49 × 10 ⁶)	(9.65 × 10 ⁵)	(1.36 × 10 ⁶)	(1.42 × 10 ⁶)
.3/.6	(2.16 × 10 ⁶)	(1.43 × 10 ⁶)	(1.14 × 10 ⁶)	(7.07 × 10 ⁵)	(9.69 × 10 ⁵)	(9.19 × 10 ⁵)
.4/.5	(1.41 × 10 ⁶)	(8.63 × 10 ⁵)	(7.87 × 10 ⁵)	(4.49 × 10 ⁵)	(5.74 × 10 ⁵)	(4.13 × 10 ⁵)
.5/.4	(6.71 × 10 ⁵)	(3.00 × 10 ⁵)	(4.33 × 10 ⁵)	(1.91 × 10 ⁵)	(1.79 × 10 ⁵)	9.27 × 10 ⁴
.6/.3	7.08 × 10 ⁴	2.62 × 10 ⁴	(7.94 × 10 ⁴)	6.65 × 10 ⁴	2.16 × 10 ⁴	5.98 × 10 ⁴
.7/.2	8.13 × 10 ³	8.25 × 10 ³	2.74 × 10 ³	3.25 × 10 ³	6.11 × 10 ³	1.10 × 10 ⁴
.8/.1	1.55 × 10 ³	1.39 × 10 ³	6.28 × 10 ²	5.82 × 10 ²	1.01 × 10 ³	1.61 × 10 ³

To examine this issue, the production level, Y , was set to zero and equation (11) is rearranged to isolate τ :

$$(35) \quad \tau = -(p-d) \frac{(r+h)}{k}$$

This indicates the tax level at which production of the commodity would become unprofitable and, presumably, would cease. The zero production level tax is shown for each primary model configuration in Table 4. Not surprisingly, those crops which are more profitable without a tax are able to sustain higher tax levels before becoming unprofitable. These levels may be thought of as a maximum potential tax, constrained by the physioeconomic system, regardless of the theoretical social weights applied. Similarly, there is a tax level for each commodity, less than the zero tax level, at which all of the

resources of the area will be placed in use. Equation (11) was again rearranged, this time leaving the variable Y explicit in the equation:

$$(36) \quad \tau = -(-p + d + 2gY) \frac{(r+h)}{k}$$

The average yield per acre was multiplied by total acres in the study area and substituted for Y in (37) to obtain the full production tax levels (Table 4). Any tax below these levels will not affect the production decisions of farmers. Each zero tax level and full production tax level is associated with a pair of values of a and b . This effectively sets a bound on the range of social weights that can affect production of agricultural products. The range of possible social weights fell between .4/.5 and .7/.2 for a/b . This suggests that severely skewed social weights are not sustainable under the conditions in the study area. It may, perhaps, be inferred from this limited application that the importance of both goods to a healthy society may preclude an extreme bias in either direction. Since price is a determinant of this range, the market itself may act exogenously as a stabilizing force.

The use of any weighting scheme must give rise to the question of how the weighted values compare to the same system unweighted. A non-weighted value was obtained by solving the system again without the a , b , or c coefficients:

$$(37) \quad \tau = \frac{(h+\delta)(p-d)(r+h)}{k(2h+\delta)} - \frac{ph(h+\delta)}{k(2h+\delta)} + \frac{\gamma h}{(2h+\delta)}$$

The non-weighted equations resulted in the values shown in Table 4, which represent the actual transfer of value from society to agricultural producers for each primary model configuration. These economic transfer values were just over three dollars per ton for corn and soybeans, and were substantially lower for wheat.

An analysis was performed of the sensitivity of the economic transfers, the zero production tax level and the full production tax level to changes in the model coefficients. The model is extremely sensitive to changes in price; moderately sensitive to changes in the linear cost coefficient, the private instantaneous rate of discount, and the sediment growth coefficient; and relatively insensitive to changes in the quadratic cost coefficient, the social instantaneous rate of discount, the unit cost of offsite sediment damages, and the sediment decay coefficient.

The Dynamic Policy Frontier

The variable weights in the policymaker's model allows the modeler to develop solutions independent of policy goals. The parameterization of relative weights, a , b , and c , in the model provides for a range of answers as shown above. For the sake of clarity, the tabular weights were limited to changes in coefficients a and b . A graphical representation provides a better means to examine the relationship between the optimal tax function and the values of all three coefficients, a , b , and c .

The graphical policy frontier for conventional corn is shown in Figure 3. The optimal tax rate is shown on the vertical axis and the variable a is shown on the horizontal axis. Each line in the graphs represents a constant value of c . The value of b can be calculated for any given point as $b = 1 - a - c$, however, the scale of b changes for each value of c , and is not shown explicitly.⁶

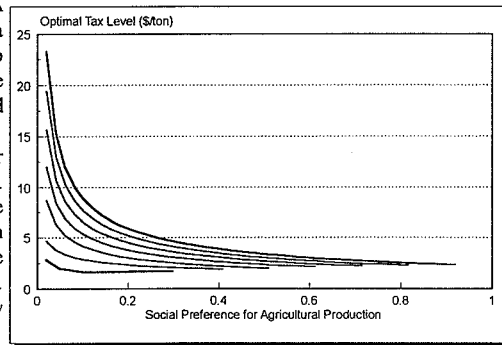


Figure 3. Dynamic policy frontier for conventional corn.

⁶ The choice of a is arbitrary. Variable b could have been explicitly shown on the horizontal axis, with a implicit.

Conclusions

The model demonstrated here is a special form of a Stackelberg differential game model, applied in such a way as to examine the relationships between agricultural producers and society as regards both the benefits of agricultural production and the external costs of soil erosion. The model provided information on the rates of taxation that would optimize the resources of both society and farmers given the preference of society for agricultural output versus environmental quality. These optimal tax rates represent the transfer of costs from the agricultural producer to society as a whole. The optimal tax rates were then substituted into the optimal production function for agricultural producers to determine the level of production that may be expected to result given the underlying profit structure of agricultural production and the tax rate applied.

Effective optimal taxes were determined, which would result in a range of production from zero to full production, and was identified as a bound on tax rates which would be expected to affect levels of agricultural production. The range of taxes, from full to zero production, respectively, were \$2.04 - \$3.04 per ton of erosion for conventional corn, \$2.07 - \$3.40 per ton for conservation corn, \$2.24 - \$2.87 per ton for conventional soybeans, \$2.54 - \$3.47 per ton for conservation soybeans, \$0.33 - \$1.19 per ton for conventional wheat, and \$-0.22 - \$0.56 per ton for conservation wheat. All values are in dollars per ton of sediment.

Tax rates less than the full production tax rate are expected to reduce society's cost of agricultural production without reducing output of the commodity being modeled. Tax levels in the effective range are expected to both reduce agricultural output of the commodity, to reduce offsite sediment damages from agricultural production, and to reduce the cost to society of remaining agricultural production. Tax levels greater than the zero production level are expected to result in a complete shift in production from the commodity being modeled to another enterprise. The model does not address what new enterprise that would be, nor its relative environmental impacts.

External costs of production were also calculated to indicate the absolute transfer to society, without regard to social preferences, of offsite sedimentation costs arising from agricultural production. The external costs, in dollars per ton of sediment, are \$3.11 for conventional corn, \$3.35 for conservation corn, \$3.03 for conventional soybeans, \$3.45 for conservation soybeans, \$1.37 for conventional wheat, and \$0.61 for conservation wheat.

As is characteristic of mathematical models, some concessions were made in the name of mathematical tractability. While the model is able to address both the producer's problem and the policymaker's problem, each optimal control sub-model is constrained to one state variable and one control variable. While the policymaker's model expresses a second equation of motion in equation (17), that equation satisfies the constraint by becoming zero due to assumptions in the producer's model. The model would be rendered analytically insoluble if this constraint were violated.

Another assumption resulting from these constraints is that of the exogenous price level. It was shown in the sensitivity analysis that the model is particularly sensitive to price, yet the model is unable to adapt to such changes endogenously. The constant price assumption causes the result shown in equation (9), that the change in the producer's optimal production over time is equal to zero. Without this assumption, the second equation of motion in equation (17) would be non-zero and the model would be analytically insoluble. Such constraints could be abandoned in a purely numerical model. Such a numerical model would be the expected form of this modeling type in practice.

Many of the problems addressed by this model also exist in New Zealand. As in the United States, the application of soil erosion policy research should focus, among other things, on the relationship between agricultural producers and society. The offsite effects of soil erosion should be studied carefully, and control of erosion should be approached through economic instruments rather than physical controls. To be useful in New Zealand additional research on this modeling system should include the addition of multiple controls to both the producer and policymaker sub-models, the inclusion of price as an endogenous variable in the modeling system, the econometric estimation of agricultural cost functions, and the development of physical and economic measures of offsite damages from agricultural soil erosion.

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BEEF PRODUCTION FROM DAIRY VS BEEF ANIMALS: RESPONSES TO MANUFACTURING AND PRIME BEEF PRICE RELATIONSHIPS¹

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INTRODUCTION

New Zealand beef production has traditionally been based on the maintenance of a large beef breeding herd to supply young animals for fattening for the market. Beef breeding was complementary to sheep farming from a management perspective in the most common sheep/beef system, but was in competition for resources on farms.

Production of beef from dairy based animals developed into an important activity during the 1980s. This eventuated from the realisation that surplus male dairy calves with suitable breed attributes can be used for producing manufacturing type lean beef enjoying market demand, at much lower cost. It also reflected growing awareness and acceptance of the management systems associated with running bull beef and the opportunities available.

Changing circumstances, in particular, changes in the relative price of prime beef to manufacturing type beef and higher real interest rates, required a change of strategy. The growing significance of dairy beef production in New Zealand during the 1980s and early 1990s was a good example of such strategic choices made by beef/dairy farmers in New Zealand.

The growing importance of dairy beef operations over the last 10-12 year period has recently shown signs of some levelling. There may actually be some reversal of the developments of the last decade, depending on the realisation of various forecast price relativities in the future.

Actual and expected market developments, some of which are GATT related, in the traditional North American and newer Asian markets for various types of New Zealand beef, both prime and manufacturing as well as grain-fed and grass-fed beef, are some of the reasons for this development.

OBJECTIVES OF THE PAPER

In the context of the above observations on the traditional beef sector and the dairy beef industry, the specific objectives of this paper are as follows:

- to provide an overview of overseas demand for beef;
- to describe the level of traditional beef production activities;
- to outline dairy beef production developments and reasons for them;
- to identify factors determining the balance; and
- to consider a "most likely " and other price scenarios and the related responses using the Pastoral Supply Response model.

NATURE OF OVERSEAS AND DOMESTIC DEMAND FOR BEEF

US/Canada

Demand for table beef in the US and Canada is dominated by grain fed beef reflecting consumer preferences. New Zealand's exports to this sector of the market are fairly minimal. Exports to the US and Canada are directed mainly to the food processing industry, although more of the exports are for table beef consumption.

New Zealand and Australian lean beef derived from cows and bulls is mixed with fat trimmings and offcuts of grain fed table beef for use in the food processing industry. The main end uses of this beef are in hamburgers, sausages and salamis.

The growing trend to convenience foods and eating out is shown up in expanding fast food outlets. This points to the demand for manufacturing type meat continuing to increase. However, as competition from poultry and pork is intense and overall supplies of beef and competing meats are increasing faster than the demand, the result has been a decline in real prices.

Existing high levels of per capita meat consumption in the US suggest that the room for future expansion of meat demand is limited. US meat consumption per capita in 1992 was 119 kg compared with 99 kg in NZ.

Japan/Korea

Beef is not widely used for manufacturing purposes in Japan or Korea because of its high cost relative to other meats. High tariffs on beef, import restrictions in the case of Korea, and smaller fast food outlets result in higher prices which further limits the use of manufacturing beef.

Demand from the table beef segment is for prime beef cuts. In the case of Japan it has largely been for grain fed or grain finished beef. However, grass fed beef is in demand in the lower middle income segment of Japanese society which is more price sensitive.

Korean demand for beef has been distorted by government import controls and administrative mechanisms, which in recent years, have favoured grain fed beef. Nevertheless, increasing quantities of grass fed prime beef have been purchased to satisfy growing demand from the more price sensitive lower-middle income segment of the market. The current low level of consumption suggests that there is considerable scope to further expand demand for grass fed prime beef as the market is liberalised.

¹ Views expressed in this paper are those of the authors and do not necessarily reflect the official view of the Ministry of Agriculture and Fisheries. The helpful suggestions and comments of colleagues at MAF Agriculture Policy are acknowledged. Errors and omissions remain the responsibility of the authors.

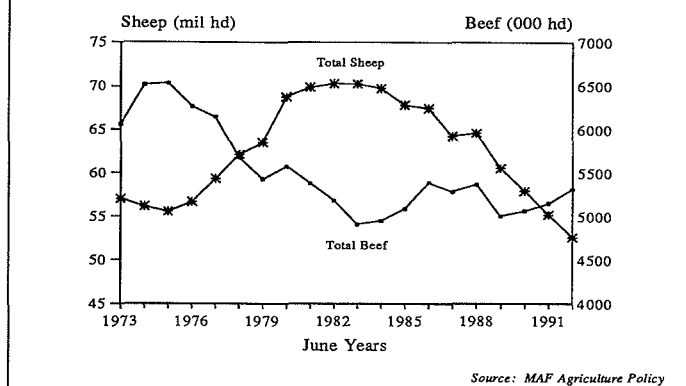
New Zealand

NZ domestic demand for beef has fallen over the last decade in response to high prices relative to poultry and pigmeat, sluggish growth in consumer incomes and health concerns. This has resulted in beef consumption per capita falling from 56kg in 1972 to 30 kg in 1992. The fall in consumption of beef has impacted most heavily on prime beef with manufacturing beef benefiting from an expansion in hamburger demand offsetting to some extent lower usage for other processed beef products, eg sausages.

TRADITIONAL BEEF SECTOR

The beef herd which numbered over 6 million during the mid 1970s had declined to about 4.8 million by the early 1980s, when sheep numbers exceeded 70 million. Since then, beef numbers recovered to about 5.0 million, while sheep numbers declined to about 52 million in 1992 (figure 1).

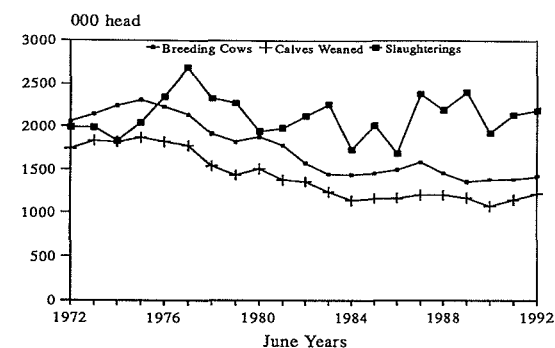
Figure 1: Total Sheep and Beef Numbers - 1972-1992



The beef herd consists of traditional pure beef breeds such as Aberdeen Angus and Hereford and to a lesser extent Murray Grey, Shorthorn, Charollais, Siemental and the crosses between these breeds. These animals produce a large proportion of the prime table quality beef in demand for the butcher, restaurant and supermarket trade in New Zealand and overseas.

Beef breeding cows and heifers, which numbered over 2 million during the mid 1970s declined to about 2 million in the mid 1980s (figure 2), corresponding with the decline in total beef cattle. This decline was followed by a small recovery in beef breeding numbers in the late 1980s, but have been fairly stable so far during the 1990s. Calves weaned had closely followed beef breeding cow numbers with about an 86% weaning rate on average.

Figure 2: Beef Sector Numbers



The size of the beef breeding herd and the total beef herd declined as a result of farmers' decisions to carry out major destocking first in 1977 followed by further slaughterings in 1983, 1987 and 1989. This was reflected in sharp increases of adult cattle slaughterings in those years (figure 2).

Decomposition of Adult Cattle Slaughter

Total adult cattle slaughter fluctuates considerably in response to variations in prices, costs and seasonal conditions. Both beef and milkfat prices impact upon adult cattle slaughter but their effects are somewhat different on the components of cattle slaughter such as bulls and mature steers, cows, heifers and young steers.

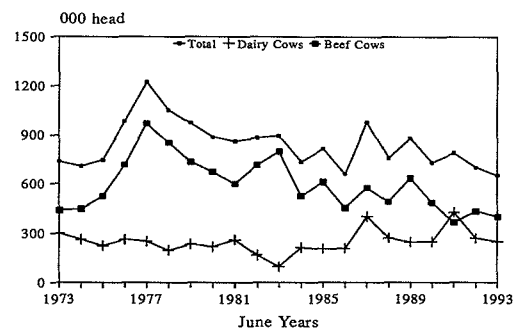
Total adult cattle slaughter variation reflects closely the variations in older (>2 yr) cattle slaughter consisting of both dairy and beef cows, as well as mature steers and bulls. During the drought year of 1989, mature steers and bull slaughter reached 873,000, well above the usual level of between 600-700,000 head, as farmers reduced livestock numbers in response to feed shortages.

Slaughter of younger cattle (ie 1-2yr steers and heifers) have been fairly stable at around 900,000 head during the mid to late 1980's period. But they declined to about 800,000 in the early 1990s with better beef prices being realised.

Decomposition of Cow Slaughter

Total cow slaughter consists of beef cow slaughter, which varies mainly in response to changes in prime beef, and wool prices, and the culled dairy cow slaughter (referred to as the transfers of dairy cows) which varies mainly in response to milkfat prices (figure 3).

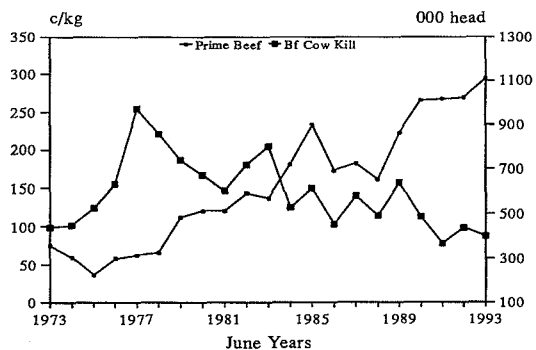
Figure 3: Decomposition of Cow Slaughter into Beef and Dairy Categories



Source: MAF Agriculture Policy

Beef cow slaughter is the main component of total cow slaughter and mirrors it very closely. Beef cow slaughter increased sharply up to 1977. Since then it had followed a declining trend following the general increase in nominal prime beef prices (figure 4a). This inverse relationship has been very striking during the 1989-93 period. Some of the peaks in beef cow slaughter is attributed to adverse weather conditions such as droughts.

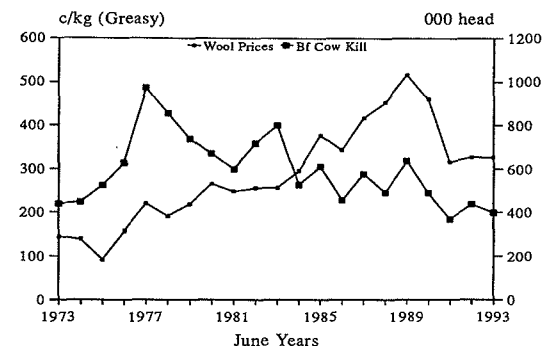
Figure 4a: Prime Beef Prices and Slaughter of Beef Cows



Source: MAF Agriculture Policy

High levels of beef cow slaughter were experienced in 1977, 1983, 1985, 1987 and in 1989. Most of these peaks coincided with the major increases in nominal wool prices (eg, 1977, 1985 and 1989) as can be verified in figure 4b.

Figure 4b: Wool Prices and Slaughter of Beef Cows



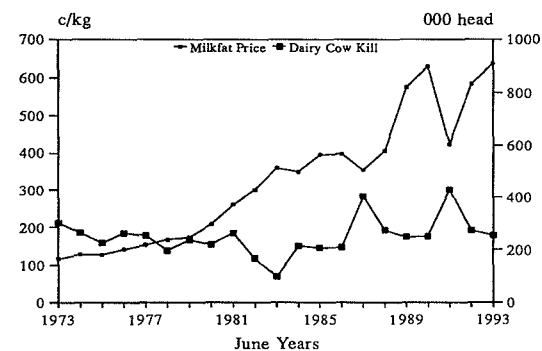
Source: MAF Agriculture Policy

Dairy Cow Slaughter and Milkfat Prices

Reconciliation of dairy sector census data is carried out for the Pastoral Supply response Model (SriRamaratnam and Reynolds, 1989). This process has enabled the derivation of dairy cow slaughter, which is the residual component of total cow slaughter.

Dairy farmers' usual response to declining milkfat prices is to intensively cull older dairy cows. Decline in milkfat prices in 1987 (10%) and 1991 (30%) resulted in a significant increase in dairy cow slaughter (figure 5).

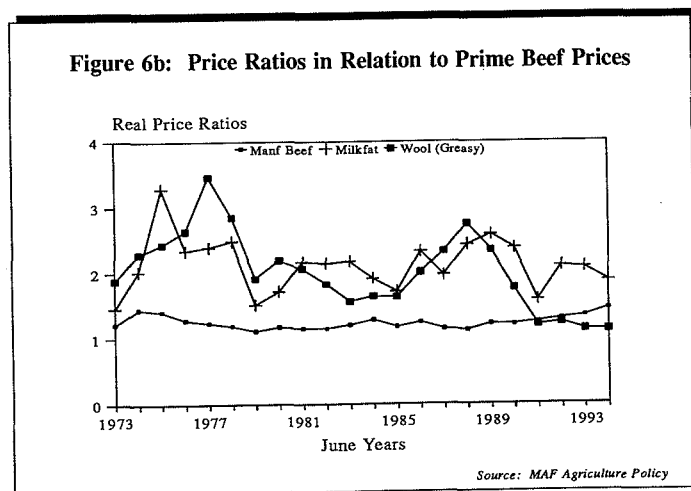
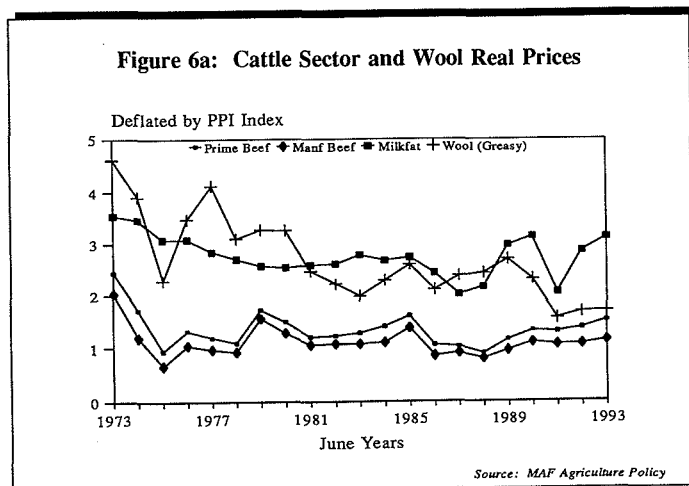
Figure 5: Milkfat Prices and Slaughter of Dairy Cows



Source: MAF Agriculture Policy

Price and Price Relativities

The major changes in the size of the beef breeding herd were associated with changes to the slaughter of beef cattle and in particular beef breeding cattle (ie beef cows). These are cumulative responses by sheep and beef farmers to real prices (figure 6a) and price relativities (figure 6b) or the price ratios between prime and manufacturing beef, milkfat and prime beef and wool and prime beef.



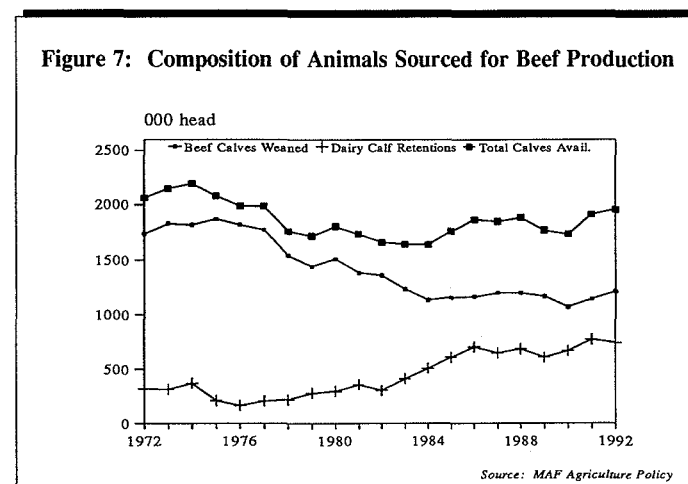
Real prime beef and manufacturing beef price declined sharply in the mid 1970s, but since then have been less volatile. Since 1989 prices have steadily increased and by 1993 were at similar levels to early 1980s (figure 6a).

Real wool and milkfat prices, however, have been much more volatile. Wool prices have followed a general declining trend and were very low in 1975, 1983, 1987 and more recently since 1991. Milkfat prices also have followed a declining trend until 1987, but have followed an increasing trend since, with the exception of 1991 (figure 6b).

Price relativities within prime and manufacturing beef and between beef, wool and milkfat prices are as important as the level of real prices. These factors influence farmers' decisions to substitute enterprises. The ratio of prime beef to manufacturing beef has varied within a very narrow band of about 1.1 to 1.3. Milkfat to prime beef price ratios (1.7 to 2.6) and the wool to prime beef price ratios (1.1 to 2.7), however have been more volatile reflecting the volatility in milkfat and wool prices (figure 6b).

Sourcing of Calves for Beef Production

Traditionally, beef animals were sourced from the beef herd with beef calves weaned accounting for over 80% of total calves available for beef production in the 1970s (figure 7). Dairy calves retained for beef made up the rest, but were much less significant in most years (less than 20%).

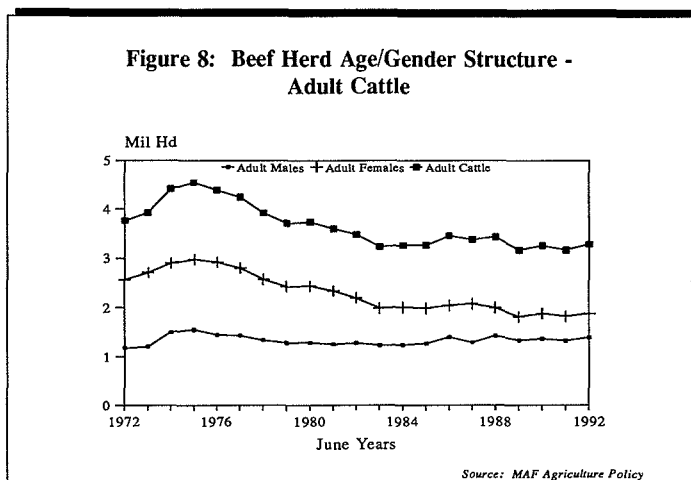


During the 1980s, with the increasing availability of heavier dairy calves from the expanding Friesian herd, the proportion of beef animals sourced from the dairy herd rose to about 35% of the total. At the same time, calves sourced from the beef herd declined to about 65% in the mid 1980s (figure 7).

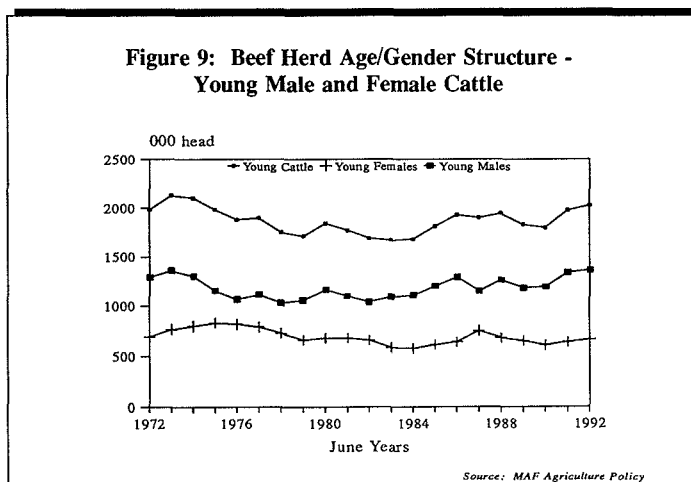
This trend continued into the early 1990s, with about 60% of calves for beef production sourced from the beef herd, and the rest (40%) from the dairy herd (figure 7). This numbered about 1.2 million calves from the beef herd and about 750,000 calves from the dairy herd, and the total calves available for beef production rose to about 2 million from about 1.8 million in the 1980s.

Beef Herd Structure & Breeding Stock

The consequences of the developments in the dairy industry and its growing significance in supplying animals for beef production in recent years, have led to some important changes in the structure and composition of the beef herd. They are reflected in changes in the ratio of adult (more than 1 year) males to females (figure 8) as well as the ratio of young male calves (less than 1 year) to young female calves in the beef population (figure 9).



The adult males consisted of about 35% and the adult females about 65% of the adult (more than 1 year) beef cattle population, during the mid 1970 period (figure 8). The adult male component, however, has gradually risen to about 45% and the adult females component declined to about 55% during the early part of the 1990s (figure 8).



Associated with this was the decline of adult cattle (> 2 yr) population from about 4.5 million in the 1970s, down to about 3.5 million in 1992. The calves (under 1 year) available for beef production declined from over 2 million in 1972 to about 1.7 million during the mid 1980s and have recovered again to over 2 million in 1992 (figure 9).

This is partly attributable to additional dairy calves retained for beef production, more than compensating for the decline in beef calves weaned as a result of the drop in the beef breeding herd from about 2 million in 1980 to about 1.5 million in 1992 (figure 2).

IMPORTANCE OF DAIRY BEEF DEVELOPMENTS IN THE MID 1980'S

The joint nature of meat and wool production in sheep farming has long been acknowledged, and while meat is the main product and wool the by-product in some systems, the opposite is true in others. Similarly, beef and veal have been noted as by-products of the dairy industry, where beef was derived essentially from culled dairy cows in the past.

But over the last ten years or so, farmers in New Zealand have increasingly recognised the potential of using dairy bull calves for finishing as beef animals. More recently, bull beef production has grown in popularity as a specialist operation.

Increasing proportions of heavier dairy calves being available from pure bred Friesian and its cross bred herds which account for about 65% of the total dairy herd at present, higher gross margins from dairy bull calf fattening and less labour and feed (pasture) requirements compared to maintaining a beef breeding herd, have all contributed to a greater use of dairy based animals for beef production.

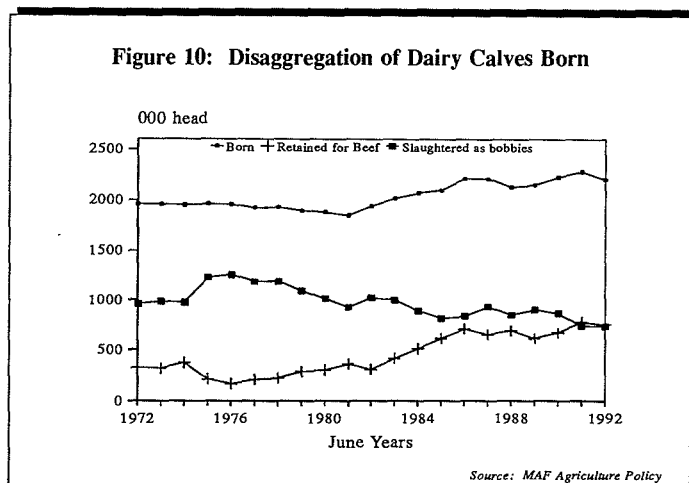
Disaggregation of Dairy Calves Born

Calves born in the dairy herd are the source of replacement of breeding stock in the dairy industry. Surplus calves traditionally went to bobby veal production from dairy calf slaughter, but in recent years there has been a growing number of dairy calves being retained for beef production.

The supply of dairy calves have been expanding. During the 1970s, just under 2 million dairy calves were born, but during the 1980s over 2 million dairy calves were born each year. In the 1990/91 season, more than 2.3 million calves were born in the dairy sector (figure 10).

Of the dairy calves born, about 70% are either used for bobby veal production, or are retained for beef production on dairy and/or beef farms each year. Besides the 6-7% of calves that are lost on farms, the rest (20-25%) are mainly female replacements for the breeding herd.

Over the years however, fewer calves have been killed as bobbies, (1.2 million in 1975, down to 0.8 million in 1985) and more were retained for beef production. This trend continued into the early 1990s but at a faster rate due to the popularisation of dairy beef systems and increasing proportion of Friesian breed cattle in the national herd (figure 10).



While only about 20% of the dairy calves (out of the 70% not used as dairy replacements) were retained for beef production in the mid 1970s, more than 35% were kept for beef in 1992. This amounted to about 850,000 dairy calves in 1992, up from around 300,000 in the mid 1970s. Concurrently, bobby calf slaughter declined from 1.2 million in 1975 to about 800,000 in 1992 (figure 10).

RECENT REVIVAL OF BEEF BREEDING ACTIVITY

In the previous sections, the nature of production responses in the beef breeding sector in relation to both beef and wool prices and the dairy beef developments in response to beef and milkfat prices were discussed in the historical context. There was a general decline in the relative importance of the beef breeding operation and an increase in the importance of the dairy beef sector in New Zealand beef production during the ten year period from 1982-91.

Since 1991, however, there has been a slight recovery in beef breeding operations and a corresponding plateauing of the dairy beef activity. This rebalancing in the two beef production components is attributed to a major reversal in some key pastoral sector price relativities. The relative price of prime to manufacturing beef rose somewhat and was associated with a substantial decline in the milkfat to prime beef price ratio and a major decline in the wool to prime beef price ratio (table 1).

Declining access under US Meat Import Law in 1992-94, particularly affected bull beef operation which is adapted to the US manufacturing beef market segment. As a result, increased quantities had to be diverted to North Asian markets as prime cuts. This has also led to increased emphasis on traditional beef breeds.

Relative Prices - Cattle Sector and Wool

Prime beef prices were not much higher than manufacturing beef prices (ratio of 1.165) during the late 1980s, when growth in dairy beef sector was accelerating. Prime beef prices however, recovered considerably (ratio of 1.280) during the early 1990s and are forecast to improve further (ratio of 1.440) in 1994 (table 1). The prime to manufacturing beef price ratio which was narrowing during the late 1980s has widened substantially during the early 1990s.

Milkfat prices, on the other hand, were much higher relative to prime beef prices (ratio of 2.458) during the late 1980s (1987-90). Milkfat prices have since declined somewhat (ratio of 2.169) during the early 1990s (1991-93) and are forecast to further decline (ratio of 1.946) in 1994 (table 1). There has thus been a gradual decline in the relative profitability of dairy in relation to prime beef production over the 1987-94 period.

Wool prices were also high in comparison to prime beef prices (ratio of 2.441) during the late 1980s (1987-90). But, wool prices have since declined dramatically (ratio of 1.221) during the early 1990s (1991-93). It is forecast to decline further (ratio of 1.100) in 1994 but to a lesser degree (table 1). The relative returns between wool and prime beef operations which declined by about 50% between the late 1980s and early 1990s have since stabilised somewhat.

Table 1: Average Real Price Ratios - Historical and Scenarios

	Historical			Scenarios (1995-98)		
	1987-90	1991-93	1994	Base	Scen 1	Scen 2
(i) Prime/Manuf. Beef	1.165	1.280	1.440	1.312	1.200	1.400
(ii) Milkfat/Prime Beef	2.458	2.169	1.946	2.276	2.490	1.920
(iii) Wool/Prime Beef	2.441	1.221	1.100	1.853	2.230	1.480

FORECAST DEVELOPMENTS IN THE BEEF SECTOR (1995-98)

Demand

Flow-on effects from GATT Developments

As part of the GATT Uruguay Round settlement, Australian and New Zealand beef access to the US market will increase from 1995. New Zealand has negotiated specific tariff rate quotas with the US and Canada of 213,402 tonnes and 27,600 tonnes respectively from 1995. Most of the expansion in tariff quota will be filled by manufacturing beef as in previous years.

The gradual expansion in of the Korean global import quota from 106,000 tonnes in 1994 to 225,000 tonnes in 2000 and the reduction in the Japanese tariff from 50% to 38.5% should lead to some increased demand for grass fed prime beef.

Supply

Increases in beef supply over the 1995-98 period from North America, New Zealand, Australia and the Republic of Korea reflect the buildup in herd numbers over recent years is expected to outweigh the increase in demand leading to a decline in beef prices.

Forecast Price levels and Relativities (1995-98)

Base Scenario

This is the most likely scenario used by MAF Policy (Market Monitoring Group) for the Situation and Outlook for New Zealand Agriculture (SONZA) in 1994. It assumes some decline in prime beef prices, but substantial recovery in milkfat and wool prices for the forecast period (1995-98) compared to the immediately preceding period (1991-94).

The ratio of prime to manufacturing beef prices, which had increased to above 1.400 in 1994 is forecast to decline (1.312) during the 1995-98 forecast period under the base scenario (table 1). The milkfat to prime beef price which had declined gradually over the 1987-94 period to 1.946 is forecast to recover (about 2.276) during the 1995-98 period under the base forecast scenario. The wool to prime beef price ratio, which had declined dramatically during the same period (from 2.441 to 1.100), is also forecast to recover considerably (to 1.853) during the forecast period, under the base scenario.

Nominal prime beef prices which had recovered considerably since the lows of the mid 1980s (about 150 cents per kg) to a peak level during the 1993 season (about 290 cents per kg) is forecast to decline in 1994 (about 280 cents per kg) under the base scenario (table 2). The decline is forecast to be much greater for the 1995-98 period with prices in 1998 (about 230 cents per kg) about 20% less than in 1994.

Nominal milkfat prices experienced the lows in 1991 (424 cents per kg) and recovered to the highs of 1993 (638 cents per kg). They are forecast to decline in 1994 (550 cents per kg) and also 1995 (476 cents per kg) and then gradually recover at the end of the forecast period of 1998 (600 cents per kg) under the base scenario (table 2).

Nominal wool prices were depressed during the 1991 to 1993 period since the relative highs of 1990 (461 cents per kg) (table 2). It is forecast to decline further in 1994 (311 cents per kg) and then recover significantly until 1997 (481 cents per kg) and decline somewhat in 1998 (497 cents per kg).

Scenario 1: Lower beef and higher milkfat and wool prices

This price scenario sets the lower bounds in terms of the prospects for the beef breeding sector. It assumes much lower prime beef prices in comparison to the base scenario and much higher milkfat and wool prices similar to the late 1980s.

The prime beef to manufacturing beef price scenario for the forecast period (1995-98) is set at a much lower level (1.200), under scenario 1, with the milkfat to prime beef price ratio (2.490) and wool to prime beef price ratio (2.230) set at much higher levels (table 1).

Nominal prime beef prices, under scenario 1, are forecast to be lower in 1995 (225 cents per kg) and much lower in 1998 (211 cents per kg) in comparison to the base scenario.

Nominal milkfat prices are exactly the same as the prices in the base scenario, even though the milkfat to prime beef price ratio is maintained at a higher level. This is because nominal prime beef prices are set at a lower level in this scenario.

Nominal wool prices, under scenario 1, are forecast to be higher than the base scenario in 1995 (408 cents per kg) and much higher in 1998 (497 cents per kg). This represents about 10% higher wool prices in each year under this scenario compared to the base scenario.

Scenario 2: Higher beef and lower milkfat and wool prices

This price scenario sets the upper bounds in terms of the prospects for the beef breeding sector. It assumes much higher prime beef prices compared to the base scenario, lower milkfat prices, such as in 1994, and lower wool prices, somewhat better than the depressed period of the early 1990s.

Prime beef to manufacturing beef price for the forecast period (1995-98) is set at a much higher level (1.400), under this scenario, with milkfat to prime beef price ratio (1.920) and wool to prime beef price ratio (1.480) set at much lower levels (table 1).

Nominal prime beef prices, under scenario 2, are forecast to be higher in 1995 (263 cents per kg) and still higher in 1998 (246 cents per kg) compared to the base scenario and in particular scenario 1.

Nominal milkfat prices, under scenario 2, are forecast to be lower than the base scenario in 1995 (428 cents per kg) and also in 1998 (540 cents per kg). This represents about 10% lower milkfat prices, under scenario 2, compared to the base scenario as well as scenario 1.

Table 2: Historical and Forecast Nominal Prices for Scenarios									
	Prime Beef (c/kg)			Milkfat (c/kg)			Wool (c/kg Greasy)		
	Base	Scen 1	Scen 2	Base	Scen 1	Scen 2	Base	Scen 1	Scen 2
1990	266			630			461		
1991	267			424			357		
1992	269			584			328		
1993	294	294	294	638	638	638	327	327	327
1994	283	283	283	550	550	550	311	311	311
1995	246	225	263	476	476	428	371	408	316
1996	234	214	250	508	508	457	435	478	370
1997	231	211	246	552	552	497	481	529	408
1998	230	211	246	600	600	540	452	497	384

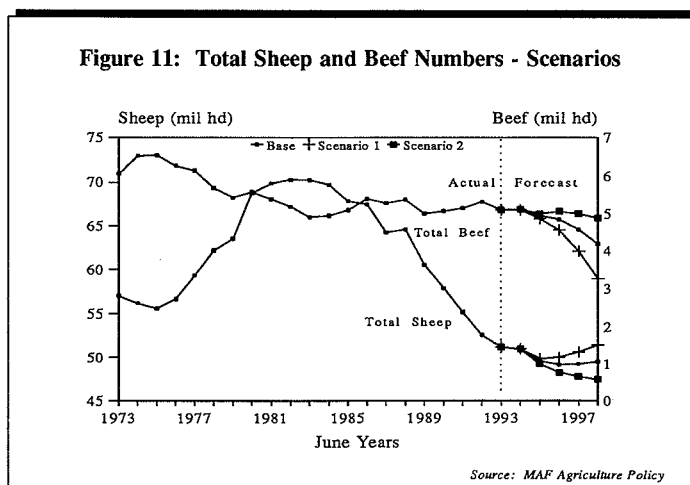
Nominal wool prices, in scenario 2, are lower than the prices in the base scenario and much lower than the prices in scenario 1. In the first year of the forecast period (1995) wool price is set at 316 cents per kg and for the last year of the forecast (1998) is set at 384 cents per kg. This represents about 30% lower wool prices than scenario 1 and about 17% lower wool prices than the base scenario.¹

Livestock Inventory and Production Responses

This section first summarises the livestock inventory responses to price assumptions incorporated in the base (most likely) scenario and to the two alternate scenarios, scenario 1 (lower beef prices) and scenario 2 (higher beef prices), which attempt to set the bounds to the base scenario.

Total sheep and beef numbers

Total sheep numbers which had declined to about 52.6 million in 1993 are forecast to decline further to about 49.4 million in 1998, under the base price scenario. Beef numbers, which were estimated to be about 5.0 million in 1993 are forecast to decline to about 4.2 million under the same base scenario (figure 11).



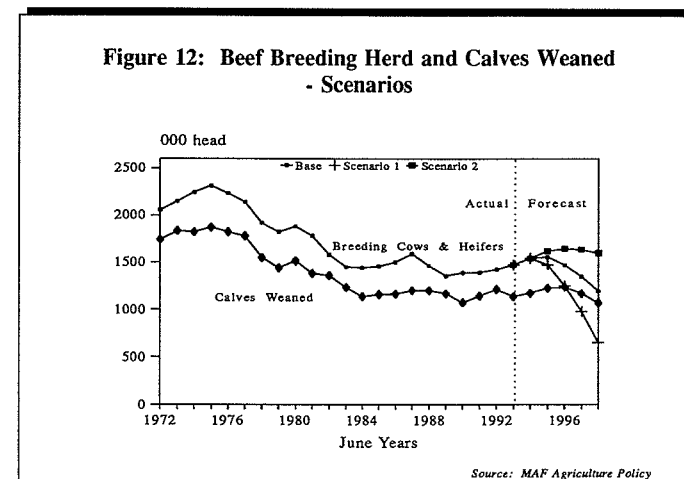
Under scenario 1, with lower prime beef prices, much higher wool prices and the same milkfat prices as in the base scenario, sheep numbers are forecast to decline to about 51.4 million only and beef numbers are forecast to decline dramatically to about 3.3 million by the end of the forecast period in 1998 (figure 11). In reality, however, this combination of prices, where ratios are maintained to favour the sheep sector for four consecutive years, is unlikely to eventuate owing to inherent annual fluctuations in commodity prices.

Under scenario 2, with higher prime beef, much lower wool prices and lower milkfat prices compared to the base scenario, sheep numbers are forecast to decline greatly to about 47.4 million and beef numbers are forecast to decline marginally to about 4.9 million by the end of the forecast period in 1998 (figure 11). In reality, however, this combination of prices, where ratios are maintained to favour the beef sector for

consecutive years, also is unlikely to eventuate owing to inherent annual fluctuations in commodity prices.

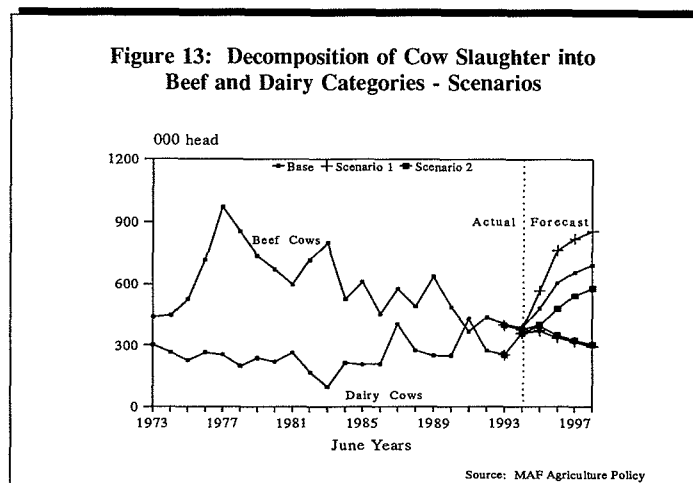
Beef breeding herd and calves weaned

Under the base scenario, beef breeding herd is also forecast to decline gradually from about 1.469 million in 1993 to about 1.187 million in 1998. At the end of the forecast period, calves weaned also decline from about 1.128 million in 1993 to about 1.066 million in 1998 (figure 12).



Under scenario 1, with lower prime beef, much higher wool prices and same milkfat prices, compared to the base scenario, beef breeding cow numbers are forecast to decline dramatically to under 0.700 million and calves weaned down to just over 0.750 million in 1998 (figure 12). This is the result of price relativities favouring the sheep sector over the beef sector for four consecutive years, as explained before, and provide a lower bound of the prospects for the beef breeding operation.

Under scenario 2, with higher prime beef, much lower wool prices and lower milkfat prices, compared to the base scenario, beef breeding cow numbers are forecast to increase considerably to about 1.592 million in 1998, to about the levels prevailing during the mid 1980s, and the calves weaned also increase to about 1.298 million in 1998 (figure 12). This is the result of price relativities favouring the beef sector in preference to the sheep sector for four consecutive years, as explained before, and provide an upper bound for the prospects for the beef breeding operation.



Decomposition of cow slaughter into categories

Under the base scenario, beef cow slaughter which was about 0.450 million in 1993 had increased to about 0.690 million in 1998 and dairy cow slaughter which was about 0.250 million in 1993 increased to about 0.290 million in 1998 (figure 13). This is consistent with declining nominal and real prime beef prices during the forecast period under the base scenario.

Under scenario 1, with low prime beef, much higher wool prices and the same milkfat prices as in the base scenario, beef cow slaughter increased to about 0.856 million in 1998, reflecting a very high level of destocking compared to the base scenario. Dairy cow slaughter increased somewhat to 0.290 million, but was similar to the base scenario level, in 1998 (figure 13).

Under scenario 2, with high prime beef, much lower wool prices and also lower milkfat prices compared to the base scenario, the beef cow slaughter level was about 0.580 million in 1998, reflecting a lower level of destocking compared to the base scenario, and dairy cow slaughter increased to over 0.300 million in 1998, owing to lower milkfat prices compared to the base scenario (figure 13).

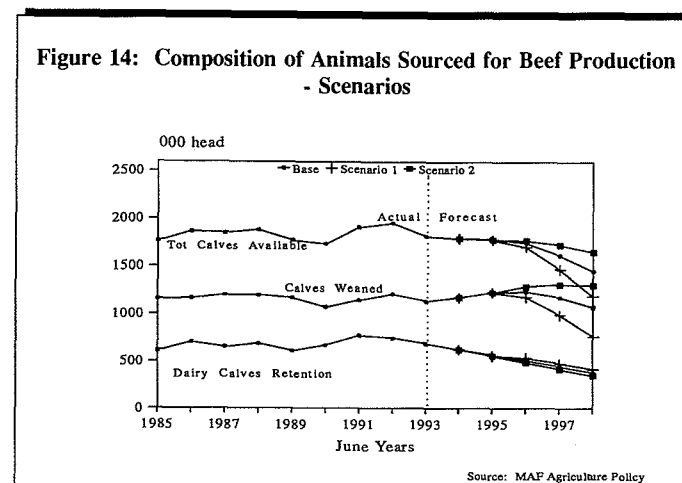
Beef cow slaughter which accounted for about 70% of total cow slaughter in 1998 under the base scenario, accounted for about 75% under scenario 1, with lower prime beef prices, and accounted for about 66% under scenario 2, with higher prime beef prices.

Composition of animals sourced for beef production

Under the base scenario, total calves available for beef production in 1998 numbered about 1.445 million and the calves weaned from the beef herd at 1.066 million accounted for about 26% of the total calves for beef production (figure 14).

Under scenario 1, with low prime beef, much higher wool prices and same milkfat prices compared to the base scenario, total calves available for beef production in 1998 numbered

about 1.179 million. Beef calves weaned at 0.765 million accounted for about 65% of the total calves while the remaining 35% were sourced from the dairy herd (dairy calves retained for beef production) (figure 14).



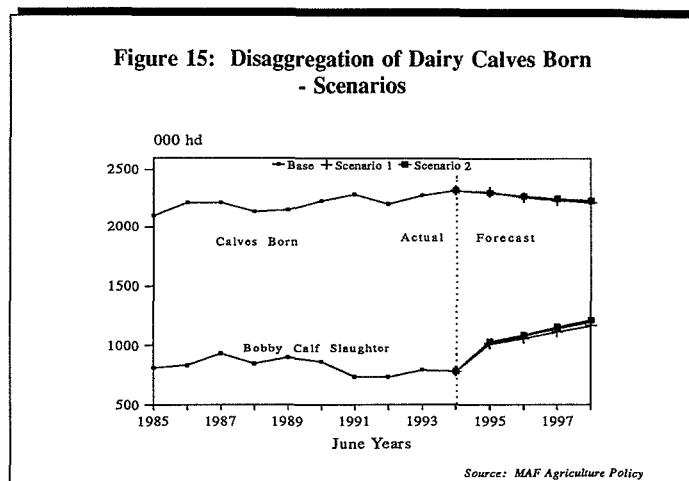
Under scenario 2, with high prime beef, much lower wool prices and also lower milkfat prices compared to the base scenario, total calves available for beef production in 1998 numbered about 1.645 million. Beef calves weaned at 1.298 million accounted for about 79% of the total calves for beef production (figure 14).

Disaggregation of dairy calves born

Under the base scenario, dairy calves born was about 2.233 million in 1998 and the bobby calf slaughter was 1.196 million, which represented about 54% of the calves born (figure 15).

Under scenario 1, with low prime beef, much higher wool prices and same milkfat prices compared to the base scenario, dairy calves born was about 2.228 million in 1998 and the bobby calf slaughter was 1.164 million which represented about 52% of the calves born (figure 15). This is consistent with a greater proportion of dairy calves retained for beef production with fewer beef calves available for beef production.

Under scenario 2, with high prime beef, much lower wool prices and also lower milkfat prices compared to the base scenario, dairy calves born numbered about 2.216 million in 1998, owing to lower milkfat prices, and the bobby calf slaughter was 1.196 million which represented about 55% of the calves born (figure 15).



SUMMARY AND IMPLICATIONS

Beef breeding has been, and still is, an important pastoral activity in New Zealand accounting for most of the beef production. During the 1980s, however, a combination of factors led to the growing importance of dairy beef mainly as bull beef operations.

Firstly, overseas market developments in the US resulted in sustained demand for lean manufacturing type beef for the convenience foods and fast food outlets. Secondly, the realisation of the potential of surplus male dairy calves suitable for beef production, at much lower cost than breeding beef, led to the increasing importance of dairy beef in total beef production. Thirdly, there were significant changes in management practices and attitudes among beef and dairy farmers which enhanced the development of dairy beef operations.

In this paper, an attempt has been made to identify and understand the implications of economic factors (ie price relationships) which contributed to this development. This analysis is extended to develop alternative price scenarios likely in the future, which result in different supply responses. The results are based on simulations using the Pastoral Supply Response Model previously developed at MAF Agriculture Policy.

The key price relationship determining the balance between beef production from the beef breeding herd and the manufacturing beef production from dairy based animals is the relative returns for prime beef compared to manufacturing beef. This price ratio which was low during most of the 1980s (about 1.1 to 1.2) increased in the early 1990s (1.28) and is forecast to be about 1.44 in 1994. This suggests that prime beef is once again receiving a substantial premium over the manufacturing beef after a period of very comparable returns.

The forecast scenarios used in this paper sets this beef price ratio at different levels to study the likely beef sector inventory and production responses. The base (most likely)

scenario used a ratio of about 1.3, whereas scenario 1 set this ratio at a lower level (1.2) and scenario 2 set it at a higher level (1.4) for the forecast period 1995-98.

Along with this main price relationship, alternative combinations of price relativities between milkfat and prime beef and between wool and prime beef prices are used in the above scenarios. These combinations of price relationships result in supply responses which reinforce the importance of these price relativities in determining the likely balance between prime beef and dairy beef production in New Zealand in the future.

The results reported for the two extreme scenarios (ie Scenarios 1 and 2) also provide an upper and lower bound to the supply responses under the most likely base price scenario in the latest Situation and Outlook for New Zealand Agriculture (1994). These alternative price scenarios are likely under alternative market developments for prime beef in relation to manufacturing beef and also the market prospects for wool and dairy products.

Under the most likely scenario, beef breeding operations will supply most of the beef produced in New Zealand with dairy beef accounting for about a quarter of the production. This is a realignment of the developments during the late 1980s and early 1990s when dairy beef accounted for almost a third of the beef production.

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**The Economics of Farm Forestry:
Some Preliminary Empirical Estimates**

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Farm forestry has been much touted as an alternative to pastoral agriculture and/or as a form of diversification for pastoral farms. This paper presents preliminary results from a study in the Bay of Plenty using a methodology developed by the Forest Research Institute. Particular attention is paid to the impact of different timber prices on investment scenarios. The paper highlights the impact of cash flow and individual farm characteristics on forest investment decisions.

**The Economics of Farm Forestry:
Some Preliminary Empirical Estimates¹**

Introduction

Agroforestry has long been a field of research by agricultural economists in New Zealand with some of the early work carried out by Chisholm (1962) and Ward and Parkes (1966). The field has continued to be of interest as the area of land planted in trees has expanded with increasing timber prices and decreasing returns to livestock farming. Analysis of agroforestry investment is complex given the long time horizon of agroforestry projects, the unique characteristics of individual agroforestry investments and technical uncertainty about productivity and costs. However with increasingly user friendly computer packages and the increasing demand for this form of analysis for both investment and soil conservation planning it has been pleasing to see the development of the Agroforestry Estate Model (Knowles and Middlemiss, 1992) by the Forest Research Institute in Rotorua. The development of such models provides the basis for analysis of agroforestry projects by professionals. This paper focuses on the use of the Agroforestry Estate Model to evaluate forestry developments on hill country in the Bay of Plenty.

The Bay of Plenty region is part of the large Central North Island wood supply region. In this region there are extensive production forests as well as smaller forests, wood lots and native forests. Estimated areas of plantings in the region were 23,900 ha in the Western Bay of Plenty, 105,100 ha in the Whakatane District and 19,400 ha in the Opotiki District. (MOF, 1994). Over 10 per cent of the total planted resource in the Central North Island is owned by a large number of forest owners with less than 1,000 hectares (MOF, 1994). It seems likely that small land owners will be the major source of increased plantings in coming years. It is expected these plantings will result from landowners pursuing income and soil conservation objectives. The Bay of Plenty Regional Council is concerned about

¹ The results are preliminary, need to be validated, and will be revised. Their value is in facilitating the identification of practical and theoretical issues in the applied economic analysis of agroforestry investments

soil erosion in the hill country and its effect on estuarine water quality (Environment Bay of Plenty, 1993). This concern is being translated into efforts to encourage tree strategic planting of trees.

Agroforestry investments involve the substitution of trees for livestock. The result is delays in cash inflows. The small immediate reduction in cash flow results in a large asset being developed over a 20 to 30 year period. Spall and Meister (1988) using a linear programming methodology found that agroforestry is likely to be a profitable investment for Wairarapa Hill Country farmers. However, despite the profitability of tree planting there is sometimes a cash constraint which limits the planting of trees. The higher prices for logs being received in the 1990s suggests the potential for conversion to agroforestry may have increased. The land in the Bay of Plenty which could be used for planting trees is land which is currently being used for grazing sheep and beef, dairy drystock or dairy cows. It is important that landowners and other investors obtain a clear view as to the economic viability of converting land in these uses to agroforestry production.

Model

The model used for these calculations is the Agroforestry Estate Model version 2.1. It uses a spreadsheet format to simulate a planting regime on model farms. The model farms used are the MAF Class 14 Bay of Plenty Dairy Farms and the MAF Class 4 Sheep and Beef Farm with some additional supporting assumptions.

The model was run for the two dominant forms of livestock farming in the district and then for five different agroforestry options on the two farm types. The agroforestry runs assumed 50 hectares of the sheep farm (18%) was planted in trees and 15 hectares of the dairy farm (21%) was planted in trees. It was assumed the land on which the trees were planted was the land of lower livestock productivity with an assumed carrying capacity of 5 LSU/ha on the sheep farm and 8 LSU/ha on the dairy farm. A low density silvicultural regime was used as per Knowles et al (1991).

Table 1
Farm Characteristics

	Sheep & Beef	Dairy
Effective area	275	71
Livestock units	2936	1312
LSU/ha	10.7	18.5
Gross farm revenue	\$140,684	\$189,580
Cash farm expenses	\$76,564	\$105,960
Cash farm surplus	\$64,120	\$83,620
Total land value	\$734,000	\$803,250
Other farm assets	\$176,160	\$305,800
Total farm assets	\$910,160	\$1,109,050
Total farm debt	\$179,110	\$148,590

Base run

The base run involved planting the trees at a rate of 5 hectares per year until the target area was reached.

Optimistic run

The optimistic run involved the same planting regime as the base run but assumed wood prices increased by 50%.

Pessimistic run

The pessimistic run was as per the base run except wood prices were reduced by 10% and costs were increased by 10%.

Fast planting run

The fast planting run assumed that on the sheep farm the 50 hectares were planted over three years with 17 hectares planted in the first year, 17 hectares in the second year and sixteen hectares in the third year. On the dairy farm all 15 hectares were planted in year 1.

Even yield planting run

The even yield runs involved planting and harvesting so as to achieve a steady state annual harvest as soon as practicable.

Results

The model produces a significant amount of output data but for the purposes of this paper only information regarding the area planted, cash flows, livestock numbers, wood flows, labour requirements, and profitability is reported.

Figure 1a shows the area planted for the base run sheep farm and figure 1b shows the area planted for the even yield planting for the sheep farm.

Figure 2a shows the cash flows for the base run sheep farm and figure 2b shows the cash flow for the even yield sheep farm.

Figure 3a shows the livestock numbers (LSU) for the base run sheep farm and figure 3b shows the livestock numbers (LSU) for the even yield sheep farm.

Figure 4a shows the wood flows for the base run sheep farm and figure 4b shows the wood flows for the even yield sheep farm.

Figure 5a shows the agroforestry labour requirements for the base run sheep farm and figure 5b shows the agroforestry labour requirements for the even yield sheep farm.

Figure 6a shows the area planted, figure 6b the cash flows, figure 6c the labour requirements and figure 6d the wood flows on the fast planting regime on the sheep farm.

Table 2 reports the net present values of the agroforestry investments and table 3 reports the difference between the alternative scenarios net present values and the net present value of the base run.

Table 2
Net present value of marginal investment

	Sheep		Dairy	
	5 % discount rate	10 % discount rate	5 % discount rate	10 % discount rate
Base run	\$14,669	\$1,974	\$11,937	\$739
Optimistic scenario	\$21,861	\$3,182	\$20,466	\$2,383
Pessimistic scenario	\$13,111	\$1,690	\$10,105	\$356
Fast planting	\$17,257	\$2,668	\$12,520	\$810
Even yield planting	\$11,083	\$1,393	\$7,794	\$268

Table 3
Percentage change in net present value of marginal investment over the base run

	Sheep		Dairy	
	5 % discount rate	10 % discount rate	5 % discount rate	10 % discount rate
Optimistic scenario	49%	61%	71%	222%
Pessimistic scenario	-11%	-14%	-15%	-52%
Fast planting	18%	35%	5%	10%
Even yield planting	-24%	-29%	-35%	-64%

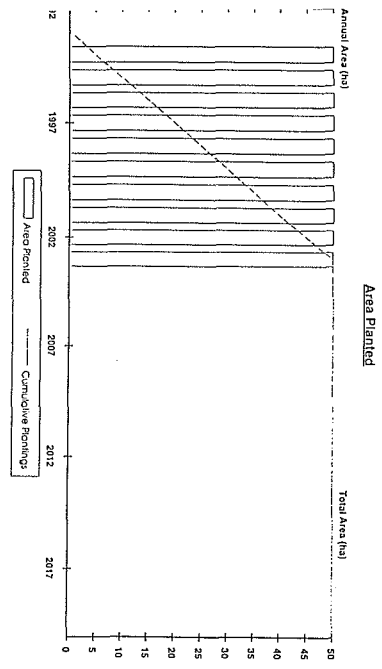


Figure 2a

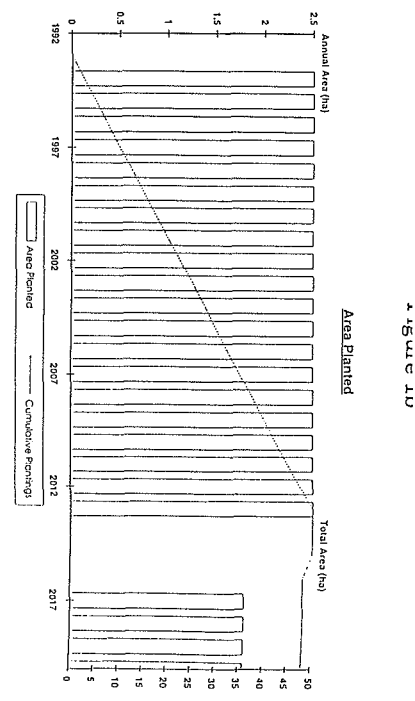
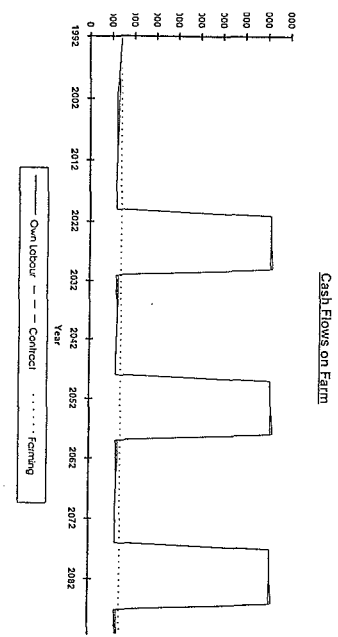
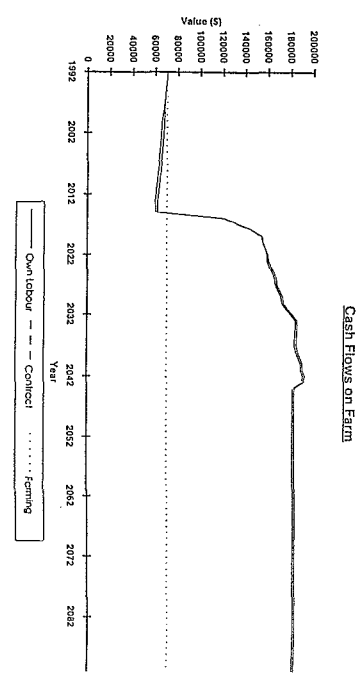


Figure 2b



The net present value calculations show that the results are very sensitive to the time frame of the project and assumptions about costs and prices. Overall they do suggest that agroforestry appears to be a worthwhile investment and worthy of more detailed analysis.

However the profit figures do not tell the whole story as the forestry investment has to be funded in some way. Figures 7a and 7b indicate the magnitude of the reduction of disposable profit which occurs on the sheep farm in the years prior to harvest based on the assumption of annual drawings and tax of \$37,000² and debt servicing costs of \$21,000. Even with a modest level of debt (\$179,110) the agroforestry regimes come close to eliminating disposable profit in the early years.

Conclusions

The AEM model is a user friendly model for evaluating forestry investments. In using this model agricultural economists and farm consultants need to obtain validated data on wood yields and livestock production under the trees. The results obtained from such investment analysis will be significantly effected by cost and price assumptions, silvicultural assumptions, farm management assumptions and the unique features of the farm or model farm being analyzed. It is particularly important that analysts take careful note of the resulting net present values and cash flow results. Ignoring cash flows could lead to liquidity crises given the nature of these investments. Ignoring net present values means analysts do not take adequate account of the time and capital used to generate the increased cash flows which result from agroforestry investments. The AEM model provides analysts helpful tools for a complex task. The challenge is for the profession to make good use of them.

² Greater sophistication in modelling taxes needs to be incorporated in the model.

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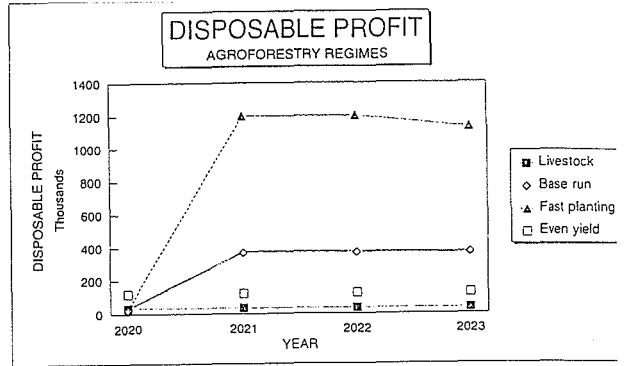
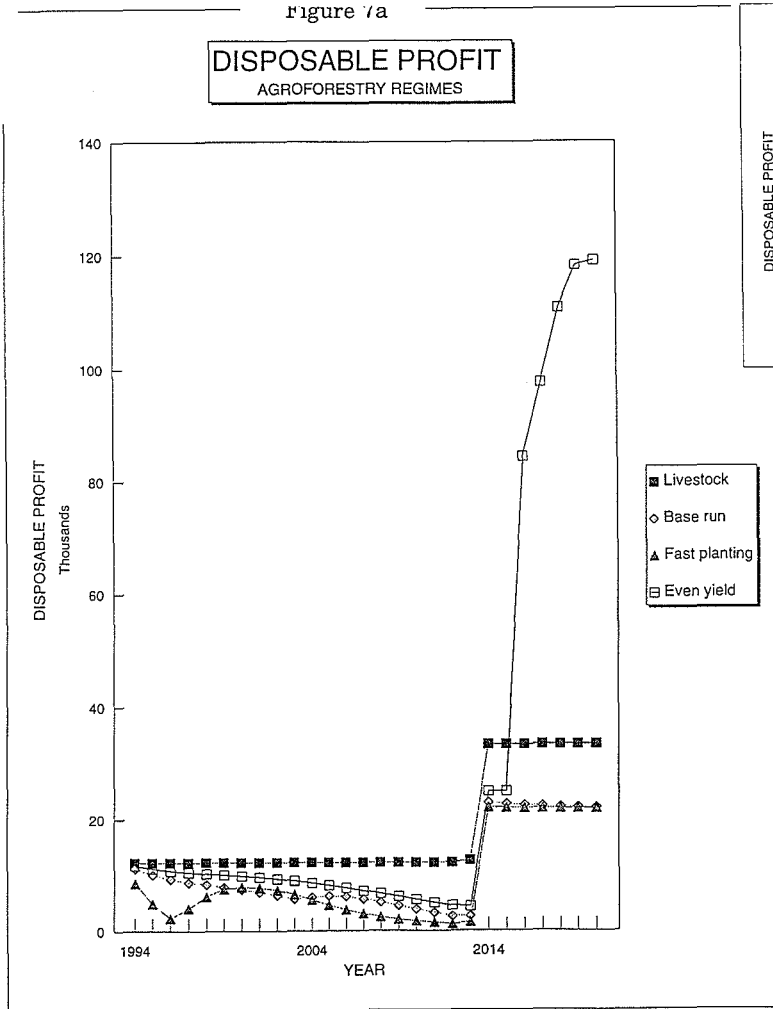


Figure 6a

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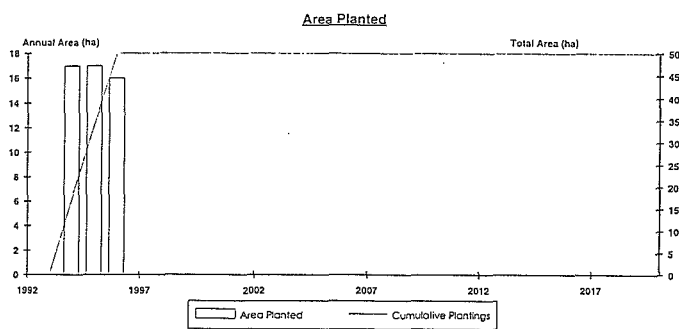


Figure 6c

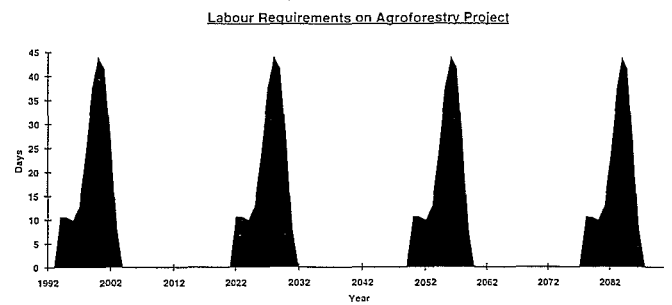


Figure 6b

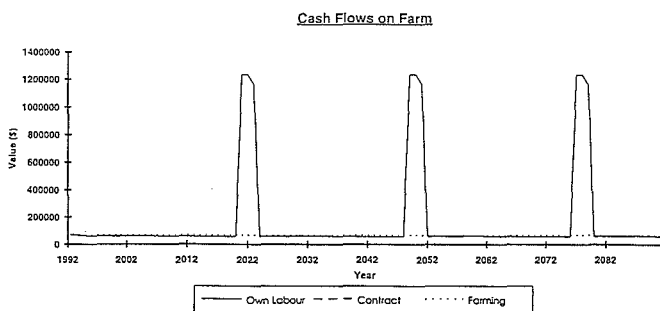
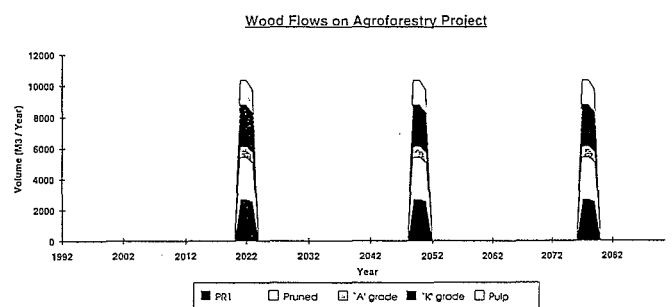


Figure 6d



APPENDIX: FOREST MODEL DATA
based on MOF (1994) and Knowles et al (1991)

Silvicultural regime, including labour requirement

Stand age (yrs)	Operation	low density stems/ha	low density labour
0	Plant	150	3
0	Release spray	150	2
3.8	Prune to 2.2 m	140	5
4.8	Prune to 3.6 m	140	5
5.9	Prune to 5.2 m	135	7
7.2	Prune to 6.3 m	75	7
8	Prune remainder to 6.3 m	60	4
various	thin to waste	15	1

Pruned log prices at the farm gate (\$/m³)

Stand age (yrs)	low density
22	179
27	210
32	234

Calculation of Unpruned log prices at farm gate (Stand ages 22-32) (\$/m³)

log grade	FOB	Wharfage	Cartage	Commission	Farm gate price
'A' Japan	165	13	9	17	126
'K' Korea	135	13	9	14	99
Pulp Korea/Japan	75	13	9	8	45

Costs for logging, loading, roading and logging supervision (\$/m³)

Stand age (yrs)	low density
22	20.2
27	18.8
32	17.0

Volumes by log grade (m³/ha) : low density

Stand age	pruned	A	K	Pulp	Total
22	124	21	116	58	319
27	158	41	161	90	450
32	182	34	198	146	560

Other costs

Labour cost for contract silviculture	\$20/hr
Supervision for contract silviculture	25% contract costs
Regrassing charge	\$450/ha
material cost at planting low density	\$85
material cost at planting high density	\$170
Supervision charge included in logging cost	\$3.5/m ³
Cartage cost	\$8.5/m ³
Fixed direct costs/year	\$58/ha

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YOUR MONEY OR YOUR LIFE

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ABSTRACT

The objective of this paper is to develop a Cost-Benefit model that presents an analysis of the costs of implementing safe agrichemical practices, being the use of recommended protective equipment, and the benefits derived from these practices, being the reduced risk of consequent health problems.

Initially, the Cost-Benefit analysis utilises surveys of the prevalence of short term acute cases of agrichemical poisoning among farmers and farm workers (inclusively termed farmers in the study), and epidemiological research on the elevated risks of cancer for farmers. The increased risks of health problems due to agrichemical exposure is then valued, using as a reference the literature on the willingness to pay for preventative action.

Secondly, the model is then further developed to simulate the cost-benefit trade-off inherent in a representative farmer's decision to use appropriate protective equipment. This analysis is used to assess the rationality of a representative farmer's decision to refrain from complying with the recommended use of protective equipment.

The final section of the paper considers the limitations of the model, and provides the reader with some conclusions and implications drawn from the analysis.

INTRODUCTION

Although the majority of New Zealand farmers believe that the safe management and use of agrichemicals is an important issue for most producers in the primary sector (Gray 1994), there is evidence that a considerable segment of farmers are not using adequate protective equipment (Pryde 1981, Houghton and Wilson 1992, Scully et al. 1993). Table 1 presents the findings of three major New Zealand studies of agricultural chemical users and their protective equipment use.

Table 1

New Zealand Agricultural Chemical Users and Protective Equipment¹

Protective Equipment Use by Body Part Protected (%)	Pryde (1981)	Houghton and Wilson (1992) ²	Scully et al. (1993) ³		
			Vegetable Growers	Pipfruit Growers	Dairy Farmers
No Protection	42.3 ⁴	28.0	8.5	4.3	36.7
Face/Head	-	-	44.0	58.5	25.7
Face/Head/Neck	24.6	26.1	-	-	-
Eye Protection		13.7	11.6	9.1	3.5
Upper Trunk	16.4	44.1	-	-	-
Lungs	-	28.6	-	-	-
Full Overalls Worn	-	-	71.3	87.5	47.0
Hands	-	-	60.4	75.0	30.2
Arms and Hands	42.0	41.6	-	-	-
Lower Trunk	15.3	44.7	-	-	-
Legs and Feet	17.8	49.7	-	-	-
Feet	-	-	49.4	70.1	20.3

¹ The findings presented for Pryde (1981) and Houghton and Wilson (1992) are the aggregated results from their survey's of farmer's practices.

² Only respondents in the sample who considered their health had been affected by agrichemicals in the previous 12 month period were surveyed on their protective equipment use.

³ Scully et al. (1993) considered the use of specific forms of protective equipment, rather than the protection of specific body areas as surveyed in Pryde (1981) and Houghton and Wilson (1992). The measure obtained on respondents use of full overalls when using agrichemicals could be considered to be equivalent to the use of protection for the upper and lower trunk and the lungs.

⁴ An additional 48.4 percent of respondents stated that they did not consistently wear protective equipment when handling agrichemicals.

Generally for farmers, the normal protection from exposure to agrichemicals is through the use of protective equipment (British Agricultural Engineers Association 1987, Scully et al. 1993). Freed et al. (1980), Pryde (1981), Davies (1984) and Cantor et al. (1992) have all found statistically significant correlations in farmer exposure and consequent health problems when measured on the basis of use/non-use of recommended protective equipment. Pryde (1981) in his study of New Zealand farmers found those respondents not wearing any protective equipment had an approximately six times greater risk of suffering acute agrichemical related health problems than those farmers using some form of protective equipment. Cantor et al. (1992) has also found that those farmers who did not use protective equipment, as compared to the entire exposed group, had a significantly higher risk of developing Non-Hodgkins lymphoma.

Despite the health risks for farmers, the non-use of protective equipment is generally considered to occur because of inadequate short term feedback (White 1993), attributed to a significant lag in the onset of long term chronic effects of pesticide exposure (Sharp et al. 1986), and inadequate training (MacIntyre et al. 1989). The conclusions drawn from these studies indicate that these combined factors have contributed to a significant percentage of farmers underestimating the health risks from agrichemical exposure, and consequently undervaluing the implementation of 'safe' agrichemical practices, especially the use of protective equipment.

AGRICHEMICAL EXPOSURE HAZARDS TO HUMAN HEALTH

Two separate classes of the agrichemical hazard to human health are commonly referred to in the literature studying the effects of chemical exposure (Who 1990). These are the acute and long-term chronic hazards.

The Extent Of Acute Agrichemical Poisoning In New Zealand Farming

Two major New Zealand surveys have provided some insight into the extent of acute agrichemical related health effects in farmers. Pryde (1981) conducted a comprehensive national survey of New Zealand Sheep, Beef and Cropping farmers to determine the extent of acute agrichemical related health complaints. 4.4 percent of the respondents indicated that their health had been affected by agrichemical usage in a 12 month period, from November 1979 to October 1980. 1.6 percent of respondents also indicated that their work routine had been affected by health complaints associated with agrichemical usage.

Houghton and Wilson (1992) also conducted a recent survey of illness and injury experience among farmers and farm workers over the period April 1991 to March 1992. In this study 8 percent of farmers reported that they thought their health had been affected by chemicals they used on the farm. 13 percent of respondents, who suspected their illness was due to chemicals, received medical treatment (primarily from general practitioners), and 25 percent of affected respondents reported they were unable to continue their normal work routine.

Although these two studies indicate a significant and increasing incidence of acute agrichemical poisonings, the results could actually underestimate the true incidence of acute agrichemical poisonings. The underestimate may have occurred as both surveys asked respondents to make a non-professional subjective statement about the causal connection between agrichemical use and health impairment.

The Risks to New Zealand Farmer's Health from Chronic Long Term Exposure to Chemicals

There is increasing evidence of adverse long term health effects from chronic exposure of humans to levels of agrichemicals that do not produce acute symptoms (Sharp et al. 1986). In addition, theoretical considerations indicate that it is impossible to determine a threshold level for a chemical carcinogen below which there is no carcinogenic risk (Schramm and Teichmann, 1977).

Many methods and study populations have been used to investigate the relationship between agrichemical exposure and cancer. However, three general lines of research have dominated the inquiry into the carcinogenicity of pesticides (see Sharp et al. 1986). One such line of research studies farming occupations as an indirect, albeit consistent, line of inquiry into the carcinogenicity of pesticides.

A second line of inquiry has been the study of pest control operators and cohorts of workers with known exposure to pesticides. Generally, these studies do not address the effects of specific pesticides but attempt to show an associative relationship between some type of pesticide exposure and a cancer outcome.

The third body of literature attempts to assess the risk of cancer from specific pesticides, notably phenoxy herbicides and related compounds, organochlorides, and DDT.

Table 2 presents a summary of this literature, outlining the nature of the research, the geographic location, the study population characteristics and the type of cancer for which an associative link to pesticide exposure was investigated. The Standardised Mortality Rate (SMR) findings are also presented. The SMR is the ratio between the observed number of events, which is assumed to be Poisson distributed, and the expected number of events, which is assumed to be fixed. However, the ratio depends on person-years at risk in the cohort, and thus on the observed numbers of events (Berry 1983). In occupational epidemiology, the standardised mortality rate (SMR) is the most common measure of a risk related to a compound.

Fasal et al. (1968), in one of the first studies on the effects of long term chronic agrichemical exposure to investigate cancer mortality and agricultural occupation, found that although mortality from all cancer was significantly reduced in farm residents, as contrasted to a control group of non-farm workers, leukaemia mortality was significantly higher among farm residents.

An increased leukaemia mortality among farmers from chronic agrichemical exposure has also become one of the most consistent findings in later studies (Milham 1971, Blair and Thomas 1979, Burmeister et al. 1982). The 25 percent increase in risk observed in Burmeister et al. (1982) is comparable to estimates from other studies (Fasal et al. 1968, Milham 1971, Blair and Thomas 1979).

Pearce et al. (1985) in a study of New Zealand farmers and horticulturalists, found the case group displayed a higher cancer mortality rate in the occupational category involving agriculture and forestry (SMR = 1.25). This excess was almost entirely among those aged less than 65 years at time of registration (SMR = 1.45), particularly among patients with multiple myeloma (SMR = 2.22), and the category including nodular lymphoma, mycosis, fungoides and unspecified non-Hodgkins lymphoma (SMR = 1.76).

Table 2

Studies Into The Delayed Health Hazards Of Pesticide Exposure

Source	Region	Study Period	Activity	Outcome	SMR
Fasal et al. (1968)	California	1959-61 (170 009)	Farming	Leukaemia	1.14
Milham (1971)	Oregon/ Washington	1950-67 (10 736)	Farming Horticulture	Leukaemia	1.26 2.3
Blair and Thomas (1979)	Nebraska	1957-74 (1 084)	Farming	Leukaemia	1.25
Wang and MacMahon (1979)	United States	1967-76 (16 126)	Pesticide Applicators	Lung Cancer Skin Cancer Bladder Cancer	1.15 1.73 2.77
Barthel (1981)	East Germany	1948-72 (1 648)	Farming	Lung Cancer	2.0
Eriksson et al. (1981)	Sweden	1974-8 (330)	Phenoxy Acid Exposure	Soft Tissue Sarcoma	6.8
Burmeister (1981)	Iowa	1971-78 (20 211)	Farming	Multiple Myeloma Lymphatic Cancer	1.27 1.14
Burmeister et al. (1982)	Iowa	1964-78 (1 675)	Farming	Lymphatic Cancer Leukaemia	1.7 1.24
Burmeister et al. (1983)	Iowa	1964-78 (8 290)	Farming	Multiple Myeloma Non-Hodgkins Lymphoma Prostrate Cancer Stomach Cancer	1.48 1.26 1.19 1.32
Smith et al. (1982)	New Zealand	1976-80 (408)	Farming	Soft Tissue Sarcoma	1.45
Cantor (1982)	Wisconsin	1968-76 (774)	Farming High Insecticide Use High Herbicide Use	Non-Hodgkins Lymphoma	1.7 2.4 2.1
Blair et al. (1983)	Florida	1965-77 (3 827)	Licensed Pesticide Applicators	Lung Cancer	1.35
Buesching and Wollstadt (1984)	Northwestern Illinois	1973-80 (1 733)	Farming	Non-Hodgkins Lymphoma	2.65
Balarajan and Acheson (1984)	England, Wales	1968-76 (1 961)	Farming	Soft Tissue Sarcoma	1.7
Cantor and Blair (1984)	Wisconsin	1968-76 (411)	Farming	Multiple Myeloma	1.4
Detzell and Grufferman (1985)	North Carolina	1976-78 (12 753)	Farming	Skin Cancer Prostrate Cancer Non-Hodgkins Lymphoma	1.8 1.6 1.0
Pearce et al. (1985)	New Zealand	1977-81 (3 670)	Farming Horticulture	Multiple Myeloma Non-Hodgkins Lymphoma Malignant Lymphoma/ Multiple Myeloma	2.22 1.76 5.51
Cantor et al. (1992)	Iowa/Minnesota	1980-82 (1 867)	Farming Herbicide Use	Non-Hodgkins Lymphoma	1.2 1.3

The New Zealand findings on the chronic effects of agrichemical exposure add to the growing body of evidence that indicates farmers are at an increased risk of developing non-Hodgkins lymphoma and multiple myeloma (cancer of the bone marrow). The observed SMR's were not large, but the use of relatively crude exposure information, such as is found on cancer registration certificates, tends to bias the observed excess risk toward the null value (Copeland et al. 1977). Hence, the true risk to farmers is likely, if anything, to be larger than the data suggest.

Many other studies (Cantor 1982, Burmeister et al. 1983, Cantor and Blair 1984) that have considered case control groups that have a greater use of herbicides, have found that their SMR is significantly elevated from the average farmer. Horticulturalists as an occupational group have also been found to have a statistically higher rate of cancer mortality (Milham, 1971, Pearce et al. 1985). These studies, that control for non-pesticide related etiologic factors, tend to support a chronic agrichemical exposure link to cancer.

Blair et al. (1983) in a study of licensed pesticide applicators in Florida, also found that the risk of lung cancer rose with the number of years licensed to spray. SMR's of 1.01, 1.55 and 2.89, were found among those licensed for less than 10 years, for 10-19 years and for 20 years or more, respectively. Ratios of directly adjusted rates showed similar patterns with observed to expected ratios of 100, 175 and 186, for the length of licensure categories. These findings further support a relationship between agrichemical exposure and cancer, and point to an increasing risk of lung cancer with the number of years licensed and agrichemical exposure.

The results of studies reviewed in Table 2 indicate a significant association between farming occupation and an increased risk of cancer. From these reviewed farming studies, calculated average SMR's for cancer mortality, by cancer type, are presented in Table 3.

Table 3

Average Statistical Mortality Rates For Farmers By Cancer Outcome⁵

Cancer Outcome	Statistical Mortality Rate
Leukaemia	1.22(4)
Lymphatic Cancer	1.42(2)
Multiple Myeloma	1.59(4)
Non-Hodgkins Lymphoma	1.6 (6)
Prostrate Cancer	1.4 (2)

⁵ Number of Studies in Brackets

THE VALUATION OF RISK REDUCTION

In making decisions about valuing acute and chronic agrichemical risks at an individual level, and whether 'safe' agrichemical practices should be implemented, an analysis is required of the benefits of safety and the costs of achieving safety. The optimum level of safety will be achieved when the risks have been reduced to the point where the cost of any extra reduction just equals the benefits, i.e. risks should be reduced until the 'marginal cost equals the marginal benefit.'

An analysis of the cost-benefit implications of agrichemical practices therefore requires that a value is placed on the reduction of risk. If this is not done, then the amount allocated to the risk reduction, as compared to the achievement of other aims, may well be inefficient. The relevant question is then, how much people will pay for a very slight reduction in their chance of premature death, or how much compensation they would require to accept a slightly higher risk.

The valuation of risk involves putting a monetary value on the saving of life. There are however often societal objections to 'putting a price on life', usually expressed by statements such as 'life is priceless'. Nevertheless it is clear that neither as a society, nor as individuals, do we treat life as priceless and having an infinite worth. For example, even those people who know that cars are more dangerous than public transport, often still travel by car when it is cheaper or more convenient (Marin 1992).

If explicit monetary valuations of the benefits of reduced risk are to be used in cost-benefit approaches to decision making, a method of calculating the required valuation is also necessary. In the next two sections this study considers the valuation of mortality and then examines the valuation of non-fatal injury.

Valuation Of Mortality

Several methodologies have been proposed for generating estimates of the value of reducing the risks of death, however, the current consensus in the economics profession is that the appropriate way to measure mortality value is to determine what people are willing to pay to save a life (Fisher et al. 1989). Willingness to Pay (WTP) estimation studies can be grouped into three categories: Wage-Risk studies, Consumer Market studies and Contingent Valuation studies.

Wage-Risk studies estimate the wage premium associated with greater risks of death on the job, while Consumer Market studies examine the observable trade-offs people make between risks and benefits in their consumption decisions. In general however, the Contingent Valuation methodology is favoured as the preferred approach to statistical life valuation, and is considered to provide estimates that are a reliable indication of the order of magnitude of the 'true life value' (Jones-Lee et al. 1985). In comparison, the Contingent Valuation approach poses respondents with a hypothetical market situation to survey their willingness to pay for alternative levels of safety.

In Contingent Valuation studies the 'value of a statistical life' is computed by surveying what people will pay on average (\$n), to reduce their probability of death per year by x^{-1} (where x^{-1} is very small). The assumption is that a group of x people, would together, be willing to pay \$ $x.n$ to avoid one expected death. Therefore in these studies a calculated \$ $x.n$ is the 'value of a statistical life' (Marin 1992).

The most recent and comprehensive New Zealand Contingent Valuation study that investigated values of New Zealand statistical life, was a study by the Land Transport Division (Millar and Guria 1991). Five willingness to pay questions yielded average values of a statistical life from \$1.07 to

\$3.22 million, with an overall average of (NZD'94)2.0 million. This study determined that the recommended New Zealand 'statistical life' value is at the low end of the range of fifty reliable international willingness to pay estimation studies, where 'statistical life' valuations ranged from \$1.5 to \$6 million (Maier et al. 1989, Miller 1990). These fifty studies include estimates from Australia, Austria, Canada, Sweden, Taiwan, the United States and the United Kingdom. The majority of these studies use the Consumer Market study methodology and provide calculated values that are consistent with the values obtained from Contingent Valuation surveys (Rice et al. 1989, Miller 1990).

Millar and Guira (1991) consider that one possible reason for the New Zealand finding being at the lower end of the range of statistical life valuations may be that New Zealand has a lower Gross National Product (GNP) per capita than that of most of the other countries surveyed. Adjusting for differences in GNP per capita, Millar and Guria (1991) found that the New Zealand mean GNP adjusted 'statistical life' valuation was not statistically different from the mean GNP adjusted 'statistical life' value from the US studies, but was below the Australian, Austrian, Canadian, Taiwanese and United Kingdom mean GNP adjusted 'statistical life' values. The US mean GNP adjusted 'statistical life' valuation is considered the most reliable figure as it was calculated by Millar and Guira (1991) from 39 of the 50 'statistical life' studies reviewed by Millar (1990).

Valuation Of Non-Fatal Injury

Willingness to Pay may also be used to value non-fatal injury. However little research has been undertaken to elicit the valuation of non-fatal injury or illness risk reduction, partly because fatal injuries generally constitute the 'worst case', and partly because death is clear-cut.

Moore and Viscusi (1988) in a US study have however made calculations of the WTP to avoid a non-fatal injury that was severe enough to involve time off work. Their findings, when adjusted to NZD'94, indicate that individuals value this element of job safety at between (NZD'94) 35 000 to (NZD'94) 70 000. Although non-fatal injury valuations are not as reliable as the value of life estimates, the range of non-fatal injury valuations, calculated by Moore and Viscusi (1988), are consistent with those values found elsewhere in the literature (Viscusi 1979). Moore and Viscusi (1988) computed this WTP value to avoid a non-fatal injury from a 'statistical life' valuation of almost (NZD'94) 14 million. From this study the valuation of a non fatal injury (which was severe enough to involve days of work) was less than 0.5% of the value of a fatal injury. Other US studies have determined similar percentages, of 1% or less, for non-fatal as compared to fatal injuries (Marin 1992). Applying a non-fatal injury valuation of 0.5% to Millar and Guria's (1991) New Zealand 'statistical life' valuation would result in a non-fatal injury valuation of (NZD'94) 10 000.

DEVELOPMENT OF A MODEL FOR ASSESSING AND VALUING NEW ZEALAND FARMERS ACUTE AND CHRONIC RISKS FROM AGRICHEMICAL EXPOSURE

The previous sections of this paper have reviewed the literature on the risks from acute exposure to agrichemicals and the increased cancer mortality risk from long term chronic agrichemical exposure. The review of the literature further examined the valuation of these risks. This section will develop a cost-benefit model that calculates the costs to New Zealand farmers of implementing safe agrichemical practices, and then values the benefits derived from these practices, measured in terms of the WTP for the reduced risk of consequent health problems.

In order to develop the model used in this study a number of factors were specified and quantified:

- (i) **The probability of NZ farmers suffering acute pesticide poisoning.**
- (ii) **The age specific risk of cancer mortality for the New Zealand Male population, and the increased Standardised Mortality Rate (SMR) for farmers.**
- (iii) **The Willingness to Pay for a reduction in the chronic and acute risks of pesticide poisoning.**
- (iv) **The length of exposure to agrichemicals and its effect on cancer mortality risk.**
- (v) **The cost of risk reduction.**

(i) Acute Pesticide Poisoning Risk For NZ Farmers

The most recent New Zealand survey of agrichemical illness and injury experience among farmers (Houghton and Wilson 1992) indicated that 8 percent of sampled farmers thought their health had been affected by chemicals used on their farm over the period April 1991 to March 1992. However, only 25 percent of the 8 percent of affected respondents indicated they were unable to continue their normal work routine. This 2 percent is the most relevant figure as the lack of published research into non-fatal injury valuation means only the valuation of injuries or illnesses that are severe enough to involve days off work can be calculated. Therefore the model does not value the 6 percent risk of acute negative health affects incurred by farmers from agrichemical exposure that does not result in time off work.

The study's 'non-fatal injury' valuation will necessarily underestimate farmers WTP for avoidance of acute pesticide poisoning risk, as the WTP literature currently does not provide suitable valuations for injuries that are less serious than those involving interruption to the work routine.

(ii) The Age Specific Cancer Mortality Risk For The NZ Male Population

In 1990 approximately 25 percent of all deaths in New Zealand were attributed to cancer according to a detailed report on cancer mortality in New Zealand published by the National Health Statistics Centre. Cancer mortality statistics from this comprehensive report for 1984-86, 1988 and 1990 for males (as the predominant users of agrichemicals) have been averaged for these 5 years by age grouping, and the averages are used as the population baseline in the model. These averages are presented in Table 4.

The studies that examined cancer mortality from occupational agrichemical exposure indicated that cancer mortality risk increased for people in farming occupations. The literature review discussed studies that had investigated the delayed health hazards of pesticide exposure. These studies indicated that the average cancer SMR for farmers was between 1.22 and 1.6. These results imply that farmers face an increased cancer mortality risk of a magnitude between 22 and 60 percent. This increased risk measure is also consistent with Blair et al. (1992) who calculated a meta-relative risk taken across 21 studies, weighted depending on the size of the study, and found that the odds ratio by cancer mortality type only rose above 2 once.

Table 4

Average Cancer Mortality For NZ Males Over 15

Age Group in Years	Deaths	Rate per 100 000 of Population at Ages Given
15-24	19.6	6.54
25-44	139.6	28.92
45-64	984.2	325.00
65+	2 212.2	1525.48

Source: Cancer Mortality Statistics, National Health Statistics Centre; 1984,1985,1986,1988,1990.

(iii) Calculated Willingness To Pay For Chronic And Acute Agrichemical Exposure Risk Reduction Used In The Model

Millar and Guria's (1991) WTP to avoid a mortality of (NZD'94) 2.0 million, that calculated New Zealander's Individual Statistical Life Valuation is used in this model.

WTP to avoid a non-fatal injury (which was serious to involve interruption to the work routine) of (NZD'94) 10 000, derived from the Moore and Viscusi (1988) and Millar and Guria (1991) studies, is also used in this model.

(iv) Length Of Agrichemical Exposure And Cancer Mortality Risk

In order to develop a model that examines the chronic risks of agrichemical exposure, it is necessary to calculate the effects of exposure duration on a farmer's cancer mortality risk. The duration of agrichemical exposure is generally considered one of the most important factors in assessing chronic agrichemical hazards to human health (Who 1990).

Barthel (1981) in an earlier study of lung cancer risk in German pesticide-exposed male agricultural workers found that there was a statistically significant relationship between the total years of exposure and lung cancer SMR. Statistical Mortality Rates of 1.2, 1.7 and 3.0 were found in subjects with less than 10 years exposure, 10-19 years exposure, and greater than 19 years exposure, respectively.

Blair et al. (1983), in a study of pesticide applicators in Florida, also found that the ratios of directly adjusted rates rose with the number of years licensed to spray, with SMR's of 1.0, 1.75 and 1.86 for those licensed for less than 10 years, for 10-19 years and for 20 years or more, respectively.

These studies all provide evidence that cancer mortality risk is significantly increased in subjects that have a longer agrichemical exposure history. Agrichemical users Cancer Mortality Risk (SMR) were adjusted for farmers by a factor to account for the effects of exposure duration. Table 5 presents the adjustment factors used in the model. These factors were derived from the findings of Barthel (1981) and Blair et al. (1983).

Table 5

The Effects Of Exposure Duration On Cancer Mortality Applied To Farmers

Length of Exposure (Years)	Adjustment Factor
>10	0.67
10-19	1.08
20+	1.44

(v) The Cost of Risk Reduction

The New Zealand Agrichemical Education Trust provides specifications for minimum protective clothing and respirator requirements for agrichemical use, by agrichemical toxicity class (Agrichemical Users' Code of Practice 1992). Research by Scully et al. (1993) into agrichemical usage indicates that the majority of growers and farmers commonly use class 3 'poisons', or agrichemicals of a lower toxicity. The annualized cost of the minimum protective equipment requirements for the mixing and application of 'poisons' is (NZD'94) 220⁶. The replacement rate for agrichemical protective equipment is estimated as one year for the average New Zealand farmer (Protective Equipment Limited 1994). As agrichemical protective equipment for the average farmer is estimated to require yearly replacement, a one-period choice model is used.

Model Specification

The health related monetarised benefits of agrichemical protection over a farmers agrichemical use history and lifespan are represented in this model by the sum of the chronic and acute risks caused by non-protected agrichemical exposure. This sum is derived from the following model which calculates an average New Zealand farmer's agrichemical exposure risk in year i .

Cost Of Acute Risks From Agrichemical Exposure

The cost of acute poisoning risk, in year i , is specified as:

$$A_i = R^A S_{NFA}$$

Where:

A_i = Cost of Acute Health Problems, in year i , caused by Agrichemical Exposure.

R^A = Risk of Acute Health Problems caused by Agrichemical Exposure Resulting in an Interruption to the Work Routine.

SV_{NFA} = Statistical Valuation of a Non-Fatal Agrichemical Accident Requiring Interruption of the Work Routine.

⁶ Source: Protector Equipment Limited, Christchurch; June 1994 Pricelist.

Cost Of Chronic Long Term Exposure To Agrichemicals

The cost of adverse long term health effects from chronic exposure to agrichemicals is specified as:

$$C_i = LE_K R^{CH} SV_F$$

Where:

C_i = Cost of Chronic Long Term Exposure to Agrichemicals in Year i .

LE_K = Adjustment Factor for Cancer Mortality Risk (SMR) by the Length of Agrichemical Exposure (K).

$K = \sum_{n,i=1}$

R^{CH} = The Cancer Mortality Risk from Chronic Occupational Exposure in year i ($CR(SMR-1)$). This is the product of the subjects age related Cancer Mortality Risk (CR) modified by a factor accounting for the increased Risk of Mortality due to Occupational Agrichemical Exposure (SMR).

SV_F = The Statistical Valuation of a Fatality (Statistical Life Valuation).

CR = The Age Related Cancer Mortality Risk.

SMR = Standardised Mortality Rate. The Increased Risk of Mortality due to Occupational Agrichemical Exposure.

Model Results

Table 6 presents the direct lifetime costs and benefits of agrichemical protective equipment for the average New Zealand farmer. Six typical cases are shown for the average farmer at various ages and with different agrichemical exposure histories.

The replacement rate for agrichemical protective equipment, for the average farmer, is yearly, and thus costs and benefits are calculated for each yearly replacement decision period. The costs and benefits for acute agrichemical risks are calculated over the average farmers working life, and the costs of chronic exposure over the average expected lifetime of the farmer.

The findings in Table 6 represent an average farmers working life, however the replacement decision for protective clothing is made by the farmer on an annual basis. Calculations for each single replacement period, used to present the aggregated findings in Table 6, however also indicate that in no single period were the replacement costs of protective clothing greater than the WTP for prevention of acute and chronic agrichemical poisoning risk in the same period.

In the case of a representative 18 year old New Zealand farmer, who has had no previous history of agrichemical use, Table 6 indicates that the costs of agrichemical protective equipment over this farmers working life with agrichemicals is (NZD'94) 10 340. Valuing the risks of acute and chronic agrichemical poisoning for the same representative 18 year old farmer, using the findings from the surveys on farmers acute poisoning incidence, and the chronic agrichemical risk estimates derived from the literature review on the increased cancer mortality risk from long term chronic exposure,

indicate that the costs of the non-use of protective equipment are from (NZD'94) 121 388 to (NZD'94) 314 821 over the representative farmers lifetime.

The findings for the other representative New Zealand farmer cases in Table 6 also identify a significant benefit-cost surplus that strongly supports the cost-effectiveness of agrichemical protective equipment use.

Table 6

Average Direct Lifetime Costs And Benefits Of Agrichemical Protection (NZD'94)

Farmer Age	Exposure History (Years Exposed)	Cost of Acute Agrichemical Poisoning Risk over the Farmers Working Life with Agrichemicals(\$) ⁷	Cost of Chronic Poisoning Risk over the Farmers Expected Lifespan(\$) ^{8,9}		Total Cost of Acute and Chronic Poisoning Risk(\$)		Cost of Protective Equipment over the Farmers Working Life with Agrichemicals (\$)
			Low Estimate	High Estimate	Low Estimate	High Estimate	
18	0	9 400	111 988	305 421	121 388	314 821	10 340
23	5	8 400	111 891	305 158	120 291	313 558	9 240
28	10	7 400	111 545	304 408	118 945	311 808	8 140
35	0	6 000	105 114	286 673	111 114	292 673	6 600
38	20	5 400	110 125	300 340	115 525	305 740	5 940
45	0	4 000	93 784	255 775	97 784	259 775	4 400

LIMITATIONS OF THE MODEL

The risk estimates that have been sourced from the studies that considered farmers and cancer mortality, may under or overestimate the actual risk from pesticide exposure. A number of factors may also understate or overstate the WTP for preventative action and the costs associated with risk reduction strategies.

⁷ The model assumes that farmers will retire from active Agricultural employment at age 65.

⁸ The average expected lifetime of a New Zealand male is 72 years (National Health Statistics Centre 1994).

⁹ The costs of Chronic poisoning risks are calculated for the minimum and maximum values of the average cancer mortality SMR indicated in the literature review.

Factors That May Cause An Overestimation Of Actual Exposure Risk In The Model

Since a farmer often functions as his own mechanic, carpenter, welder, equipment operator, and pesticide applicator, the farmer may also be exposed to many other potential carcinogenic substances in addition to agrichemicals. These carcinogenic substances may include solvents, oils, fuels, welding fumes, organic dusts and animal remedies. The exact subset of individual exposures and their effects on farmers is also dependant upon the type of farming operation.

The potential etiologic factors for non-Hodgkin's lymphoma and multiple myeloma, which may be associated with agricultural occupations, fall into three major categories: agricultural chemicals, zoonotic oncornaviruses and chronic antigenic stimuli. The findings that are presented in the studies reviewed in this report, and the nature of the survey instrument, prevent a determination of the extent to which these factors, if any, contribute to the excess of non-Hodgkins lymphoma and multiple myeloma. A possible excess risk associated with exposure to zoonotic viruses has been suggested by the high rates of cancer of the lymphatic and haematopoietic system among veterinarians (Blair and Hayes 1982). However, although there is no proven evidence of virus induced tumours in humans there are clear cases of virus-induced malignant lymphomas in animals (Malignant Lymphoma 1978).

Other possible etiologic factors are suggested by the hypothesis that non-Hodgkins lymphoma and multiple myeloma may occur after prolonged antigenic stimuli to lymphoproliferation (Greene 1982, Blattner 1982). However, it is not known if these diseases are more prevalent in agricultural communities (Pearce et al. 1985).

Factors That May Cause An Underestimation Of Actual Exposure Risk In The Model

One important factor that may underestimate the chronic exposure risk calculations in this study is the latency period of cancer. The farmer-cancer mortality association is generally evaluated by considering the occupational class that is recorded on the death certificate, or is coded from data collected at the time of cancer diagnosis, or even later if cancer registration is delayed. If the agrichemical exposure related cancer latency period is similar to that for other cancers initiated by chemical exposures, etiological exposures would have occurred many years earlier, probably in the period 10 to 30 years prior to diagnosis.¹⁰ The occupation at the time of diagnosis is only relevant if the patient has had the same occupation for many years. This will not always be the case, although the number of changes which would involve movement from one major occupational classification to another is probably very small (Smith et al. 1982).

White (1993) has further considered reasons why the risk of farmers getting cancer in many studies appear to be statistically small. Farmers are one of the largest occupational groups with exposure to pesticides, but they are also less likely to suffer from ill health generally. This is usually attributed to their higher level of fitness, younger average age, and higher intake of fruit and vegetables. Farmers are also less likely to smoke than the average person (Donna et al. 1984). Blair et al. (1992) in their review of the literature found that in all of the 21 studies analyzed, the 'healthy worker' effect contributed to an absence of a greater risk to farmers from most major diseases, including all causes, all cancers, and ischaemic heart disease. The excesses among farmers for a few specific cancers, against a background of low risk for most other diseases, however suggest work-related exposures are a factor in increased cancer mortality risks.

¹⁰ The latency period for the chemical induction of solid malignant tumours in man is generally considered to be in the range of 10-30 years (Smith et al. 1982, Sharp et al. 1986).

Another factor that may underestimate actual risk estimates is the traditionally high usage of agrichemicals by the New Zealand Agricultural sector by international standards, especially phenoxy herbicides and chlorophenols (Smith et al. 1981). This may limit the applicability of using American and British cancer mortality studies, and increase the relative risk of cancer mortality for New Zealand farmers. There is strong evidence that an increased usage of agrichemicals significantly increases cancer mortality risks (Cantor 1982, Cantor et al. 1982), however only limited support for an increased relative risk of cancer mortality for New Zealand farmers (Smith et al. 1982, Pearce et al. 1985) is evidenced.

There are however two studies (Wang and MacMahon 1979, Cantor et al. 1992) that have also investigated agrichemical exposure intensity and duration, and cancer mortality, and found no statistically significant relationship between exposure intensity and duration and cancer mortality. Cantor et al. (1992) in their study of Iowa and Minnosotan farmers found no statistically significant differences in subjects Non-Hodgkin's Lymphoma SMR by years farmed. In addition Wang and MacMahon (1979) also investigated the observed and expected deaths of US pesticide applicators by estimated relative intensity of exposure. For lung cancer, there was no evidence that risk increased with intensity of exposure, as judged from the job title; infact there was a slight though not significant trend in the opposite direction. The authors did find that the lung cancer deaths were clustered among workers who were first employed prior to age 45 and who died before age 50. Wang and MacMahon (1979) however followed relatively few subjects for 10 years or more after first employment, a significant limitation of the study in terms of the known 'latency' period between exposure and the occurrence of cancer (Smith et al. 1982, Sharp et al. 1986). Blair et al. (1983) also found that the risk of lung cancer was greater among workers first licensed before age 40. The trend of decreasing risk of lung cancer with increasing age of first exposure persisted after adjusting for length of licensure and was most evident among workers likely to have pesticide exposures.

This type of associative relationship, reported by Blair et al. (1983), has also been reported in occupational bladder cancer (Hoover and Cole 1973), smoking-related lung cancer (Doll and Peto 1981), and radiogenic cancers of the thyroid gland and breast (Boice and Land 1982). Although age-related susceptibility to cancer induction may be a contributing factor, intensity of exposure to pesticides may be involved if the younger entry-level personnel have duties resulting in heavier exposure.

The Acute and Chronic risks of poisoning to farmers, in the absence of protective clothing use, that are reported in this study, may also be understated due to the existing research methodology which generally takes no account of protective equipment use, or does not interpret the findings in relation to agrichemical toxicity. As an example of this underestimation, Cantor et al. (1992) reported a significantly higher SMR for farmers who had handled agrichemicals without protective equipment than the total sample that had handled agrichemicals with or without protective equipment.

Further, there is considerable evidence that the risks to Human Health from chronic exposure to agrichemicals include inhibition of the nervous system (Ngatia and Mgeni 1980), and behavioural impairment in terms of neurological and psychological effects (Hayes 1982, Maizlish et al. 1987, Savage et al. 1988) that this study did not consider.

Factors That May Cause An Underestimation Of The Actual Costs Of Risk Reduction

A number of experts have stated that if used responsibly, agrichemicals pose no threat to human health (Burgess 1987). The use of agrichemicals to eliminate the risks of acute and chronic pesticide poisoning requires that farmers, in addition to the use of recommended protective equipment, also have the necessary training and education to ensure the safe, responsible and efficient use of

agrichemicals. It is probable that the model developed for this study, which examines the costs of recommended protective equipment, and does not estimate the costs of complementary education and training, may underestimate the actual costs of agrichemical risk reduction.

Due to time constraints it was also not possible to estimate the indirect costs to farmers of wearing protective equipment, including time costs and discomfort costs. The omission of these costs means that the actual costs of risk reduction may have been underestimated.

Factors That May Cause An Underestimation Of The Actual Willingness-To-Pay For Risk Reduction In The Model

A refinement of the WTP approach involves recognition of the fact that safety improvements also have 'direct' economic effects, such as avoidance of net output losses¹¹, material damage and medical costs. To the extent that people, in the main, appear not to take account of such factors in assessing their WTP for improved safety, and there is some evidence that they do not (Jones-Lee et al. 1985), then an allowance for these factors should be added to values of 'statistical life' and safety. However, such negative externality additions tend to be very small in relation to the typical magnitude of the WTP *per se*, at least in the case of risks of death or serious injury (Jones-Lee 1993).

Although the WTP literature yields a cohesive value range from studies using many different approaches and data sets, there is evidence that some demographic characteristics affect the values systematically. Millar and Guria (1991) in their comprehensive New Zealand study found that income, location of residence and age had a statistically significant effect on statistical life valuation. Those individuals who were rural residents, had a lower average income, and were aged over 60, gave a lower value of 'statistical life'. Mooney (1977) has also further found that a number of factors understate 'Statistical Life' valuation. These include family circumstances, where, for example, on average, a married man with a young family values life higher than a single male with no dependants. The nature of the threat to life is also significant. WTP for avoidance of cancer mortality is higher than that for instantaneous death, for example a road accident. A higher perceived quality of future life and a respondents perceived lack of control over the risk also generally result in a valuation of statistical life over the 'mean public sector value'.

Finally, the analysis of the costs and benefits of implementing recommended agrichemical practices has not examined the costs to farmers of the considerable legislative responsibility imposed on agrichemical users for non-compliance. The Noxious Substances Regulations 1954 and The Health and Safety in Employment Act 1992 provide for the imposing of considerable penalties for non-compliance, up to a maximum of \$100 000 and/or imprisonment up to a year in the case of the Health and Safety in Employment Act 1992. S 10(2)(b) of the Health and Safety in Employment Act 1992 considers the responsibility of employers to provide suitable clothing and equipment. S 17 extends this requirement to self employed people. R 6(1) of the Noxious Substances Regulations further states that *'Every employer or occupier who handles or causes to be handled any noxious substance shall provide and maintain it in a serviceable condition, for every person so engaged as to be exposed to its effects, including himself, such equipment and clothing as is necessary to give protection from the effects, including an overall, gloves and rubber boots, and mask or goggles, as the case may require'*.

¹¹ The discounted present value of the excess of an individual's expected future output over and above his future consumption is defined as his 'net output' and would clearly represent a direct loss to the rest of society should he die prematurely.

CONCLUSIONS

The findings of this study indicate that even with the limitations of the model there is a significant benefit-cost surplus in the use of agrichemical protective equipment. In fact, the WTP for just a prevention of non-fatal acute poisoning risk is almost sufficient to warrant the cost of protective equipment.

The significant findings of this study notwithstanding, there is strong evidence of a considerable percentage of farmers not complying with the recommended protective equipment requirements (Pryde 1981, Houghton and Wilson 1992, Scully et al. 1993). This significant market failure may be attributed to informational failures by farmers that result in problems of risk perception and response.

These informational failures may be attributed to a number of factors. Firstly, although the safe management and use of agrichemicals is an important issue for most producers in the primary sector (Gray 1994), only 29.4% of vegetable growers, 32.6% of pipfruit growers and 14.2% of dairy farmers have ever attended a training course on agrichemical application (Scully et al. 1993). Despite this lack of formal chemical training there is evidence that the majority of farmers generally rate their knowledge of chemical practices, in spite of clear evidence to the contrary, as being good to excellent (Scully et al. 1993). This perception of adequate agrichemical knowledge, and inadequate short term feedback due to the significant lag in the onset of long term chronic effects of pesticide exposure (Sharp et al. 1986) adds further to problems in risk perception. Secondly, farmers may also underestimate risk by believing that accidents are a rare event, only happen to other people, or can be prevented by appropriate evasive action. These beliefs reduce the incentive to wear protective equipment.

The evidence of a significant market failure with respect to information on safe agrichemical use leads to a consideration of various risk reduction strategies that may redress the informational failure. Although there may be a potential argument for government intervention in this area, there is currently sufficient legislation in place in the form of the Noxious Substances Regulations 1954 and the Health and Safety in Employment Act 1992, that governs agrichemical and occupational safety and provides for considerable penalties for non-compliance. However, despite the evidence of non-compliance (Pryde 1981, Houghton and Wilson 1992, Scully et al. 1993) a thorough review of the agrichemical and occupational safety case law completed for this study, found no evidence of any non-compliance cases being brought forward under the relevant provisions.

In view of the apparent lack of enforcement of the agrichemical and occupational safety legislation, the significant informational failure, and the overestimation by farmers of their agrichemical knowledge, that may act as a considerable barrier to farmer's voluntary participation in agrichemical education programmes, it may be necessary for chemical application training to be made compulsory for agrichemical users under the provisions of clause 59 of the Occupational Health and Safety Bill 1991. Comprehensive procedures for monitoring agrichemical practices and enforcement of the legislation may also be warranted.

A working example of an agrichemical training programme is the New Zealand Agrichemical Education Trust's standard 'Growsafe' course. This course which is conducted over 8-10 hours at a cost of approximately \$150, provides practical and specific guidance for the safe, responsible and efficient use of agrichemicals for the control of weeds, pests and plant diseases. The course covers agrichemical management, users legislative responsibilities, transportation, storage, disposal and application of agrichemicals.

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INTEREST GROUPS, PRESSURE and POLICY DETERMINATION

Contributed paper to Winter Conference of New Zealand Agricultural
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by
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Introduction

The public choice model contends that there is creative tension between government, bureaucracy and interest groups. The characteristics of the political and bureaucratic groups are epitomised by the following quotations from Tulloch (1983):

The politician should be best thought of as a businessman. He is in the business of trying to make money by being elected to office instead of trying to make money by selling products to you. He is primarily engaged in making a living by selling policies to people and he changes them just as readily as a businessman does. We don't expect businessmen to continue selling the same car for twenty years, and we are sometimes a little indignant when we discover that politicians have been selling the same policy for twenty years - but generally they do shift positions rapidly.

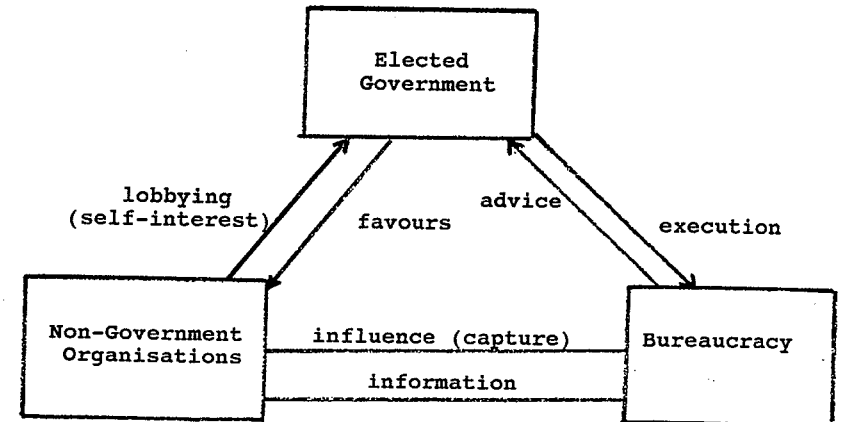
Bureaucrats are concerned with their own well-being... Bureaucrats are much like other men... They are, like the rest of us, to some extent interested in the public good and in helping their fellow men; but, like the rest of us, they put far more time and attention into their private concerns... In making a decision about some matter, (he) is likely to give more weight to the effect of his decision on his personal career than on the nation as a whole... Bureaucrats are not pressed to work hard and be efficient... They can avoid pressure from above because they cannot be fired...

More recently, Roger Douglas has put it (Evening Post, 18 June):

...when given responsibility for business, Ministers were inevitably captured by the objectives of that business, thereby taking their eyes off the bigger picture... successive Transport Ministers ...were captured by the objectives of Air NZ when it was a government department, rather than focussing on aviation policy for the country.

The three way inter-relationships between the groups is characterised by information flows and contacts between the groups and by rewards or favours bestowed as in the diagram. Pressure group activity works on both the other two groups and seeks favourable outcomes to their advantage. In this paper beneficiaries will be defined quite broadly to include more altruistic groups like environmentalists. The government political

THE POLITICAL MARKET



sector draws on public policy advice from the bureaucracy some of which is recognised to be self-interested. Information passes up to political decision makers in the form of reports and advice, and passes down to the bureaucracy in the form of political agendas and general direction of public policy. Political decision makers are seen to be part altruistic and part selfish. The altruistic part is a loosely defined concept called the national interest; the selfish part is seen to be the need to get re-elected and the need to satisfy some constituency that supports the representatives individually or supports the general thrust of the political group concerned.

Some writers call this interdependent system the political market and seek to find economic reasons for the different behaviour of the respective groups (Johnson 1991). Politicians can achieve their goals by being elected to office and bestowing favours. Bureaucrats achieve their own preferences and goals which they can achieve by enlarging the size and budgets of their agencies. Interest groups act behalf of individuals in getting favourable policies passed in the legislature. The political market is a kind of clearing house where the collective expression of individual preferences is aggregated. Resources are allocated according to the political process and not an economic one.

Information is a tool in the political market. It has characteristics of scarcity, it can be bought and sold, it can be withdrawn or withheld, and it may also exhibit public good characteristics. Pressure group activity can be seen as supplying strategic information to power holders to influence decision making. Bureaucrats have to draw on the private sector for a lot of their background information. Statistical departments exist to take on this task collectively. Holders of information have extra power to utilise in bargaining processes. Some political decision makers are particularly fond of talking about the quality of information in terms of quality decisions and the quality of their financial management. By the latter they mean a responsible fiscal policy compatible with other objectives. The public good characteristics of information relate to its free availability to all once made public and also to its key role in explaining government policies to the electorate. The latter process is subject to the same control and manipulative factors as information derived from private sources.

In this paper we discuss pressure group behaviour in terms of rent-seeking and criteria that might identify particular cases of resource transfers arising from rent-seeking. We look at different ways in which pressure can be applied and the rewards that can be sought. We look at the changing constitutional situation and ask whether this will affect the behaviour of the main parties in the political market. Will there be major changes to the bureaucratic structure and will there be changes in the ways information flows to decision makers?

Rent-seeking Behaviour

Interest group behaviour is a classic form of rent-seeking. Rents occur when the normal competitive forces at work in the economy cannot reduce or eliminate the particular situation creating the rent. Such institutional factors may be created by government as in the case of barriers to entry to a profession or business, or may be some form of natural advantage that cannot be competed away. We are interested in government created rents arising from pressure from constituent bodies or individuals seeking their own advantage. Pressure groups are a recognised feature of modern society and considerable effort is put into promoting their activities.

For the purpose of analysing and understanding specific policy initiatives I have developed a set of criteria that should help identify whether a particular policy may be instrumental in creating rents for specific groups or individuals (Johnson 1994):

- a) Does a government decision transfer economic power to an interest group or enable a new interest group to be created? An example would be the use of import control mechanisms to protect domestic markets or the creation of marketing boards.
- b) Does a transfer of wealth occur as a result of a government decision consistent with rent-seeking behaviour? Agricultural input and output subsidies operate in this way.
- c) Is the pressure group consulted in the government decision process? This can be seen to give the pressure group added leverage in the decision process.
- d) Does the decision distribute unintentional rents such as in the case of hardship relief or disabilities? This is the case for disaster relief because the expectation of relief colours the individual's decision making.
- e) Does the decision create a wealth transfer arising from a service in which the state will be in competition with the private sector? This applies to such goods as research and extension information which are capable of being partially or wholly privatised.
- f) Does the decision cause a transfer of wealth due to imbalances in information control and supply? Statutory bodies and private firms use information to influence government decision making.

The need for this kind of approach arises from the fact that government policy making is a mixture of the altruistic and the selfish. We need to establish whether transfers actually took place. Experience shows that problems have to be dealt with and new policies established. However, the resulting decisions may have redistributive effects that may or may not have been anticipated. Redistributive questions are not easy to analyse and difficult to quantify. Political viewpoints may include those of

important constituents but these may well be submerged in a mass of other detail. Some redistributive effects happen by accident.

What is important is whether the pressure group's efforts have some alignment with the existing direction of government policy. A conservative government has some sympathy with business and farmers and a labour government has sympathies with organised labour and minorities. From this start the opportunity exists for the pressure group to provide information, directly address official representatives, make party contributions and otherwise try to influence the course of policy. In our political system there is certainly an openness to points of view but also many impediments to finally achieving a change in policy.

In other countries, political appointments to the bureaucracy are utilised to increase the responsiveness of newly elected governments to its constituencies. In our system this opportunity is not present, though it has to be wondered how much contractual systems for chief executives will bring about more involvement in the political process. In our tradition, political appointments to statutory bodies, ambassadorships, public boards and the like fulfil this role for patronage. That these appointments provide some opportunity to influence the course of events is without question, but such representations as they may make will always be merged with that of others through policy advice or select committee hearings or some such.

The other strategy is to work through the media. As with the case with environmentalism, discussed below, the indirect way of influencing government policy is through public opinion. This kind of pressure is very difficult for politicians to withstand especially where public opinion is ready and able to be mobilised. As public choice indicates, pressure groups have grown up to specialise in this role and will use the available information selectively and efficiently.

It has also to be noted that media reporters tend to attribute changes in policy to reported efforts made by pressure groups (see, for example, Jesson's chapter in Gold 1991). Political favours are constantly reported but difficult to verify. There have been cases, such as the Marginal Lands Board, where such observations have been verified.

In my experience, redistributive effects usually result from policies which had some other goal. In the 60s and 70s export growth was the national goal and increased investment in farming was seen as desirable. As farm investment was a matter of private decision making (through the propensity to save) the stated policy direction required an increase in farm incomes. The policy means of achieving this was a taxpayer subsidy (a second best solution) when it would have been preferable to have made adjustments to the exchange rate (a first best solution). The net effect was a wealth transfer to the farm sector. Or take the example of the establishment of individual fish quotas. In this case, the successful holders are enriched by the policy mechanism used at the expense of other fishers who did not get quota. The redistributive

effect is the result of the more important policy objective (conserving fish stocks) being sought.

Political science writing tends to reinforce the media view. 'If class conflicts do not dominate politics, at least overtly or in the minds of most participants, sectional rivalries between more narrowly defined economic interests seem to lie at the heart of many of the most contentious policy debates' (Gold 1991,p.7). This author sees the main debate between organised labour, employers and farmers. 'All three groups -organised labour, farmers and employers - are competitors for government attention and largesse, and none, as taxpayers, can be indifferent to large favours accorded to any other group at their expense'.

Another political scientist, Vowles, states that business organisations such as the Merchants Association had little need to change during the reforms of the 1980s. 'Their approaches to Ministers and officials were invariably accepted, and consultation on key matters of concern, such as the Goods and Service Tax, were real and meaningful' (Gold 1991,p.356). This is very naive and most unlikely. In discussing the decline in consultation with pressure groups in 1984, Vowles does come to a conclusion which seems fair and reasonable '...by emphasizing the need to govern in the interests of all, and defining its role as a rule maker rather than as an active participant in a bargaining process, the state has sought to distance itself from the cut and thrust of distributional conflict between the major organised interests' (Gold 1991,p.361).

The argument that government does have a wider responsibility to the community to counter the pressures from the interest groups is promoted by the political scientists. Mulgan traces these arguments to the theory of 'countervailing power' associated with the work of J.K.Galbraith (1952). Electoral fortunes depend on the votes of the rich as well as the poor and on the individuals who make the sectional interests. Therefore politicians have the incentive as well as the moral need to look to the fortunes of the many rather than those of the few (Gold 1991,p.525). Mulgan comments on the situation post 1984 'the fourth Labour government's attitude.... was articulated in terms of the neo-liberal critique of lobbying which sees interest group influence as the attempt by powerful groups to gain unjustified 'privileges' or to 'seek rent' by capturing publicly-enforced monopolies. For neo-liberals, such as Hayek and Buchanan, the role of government should be confined to the 'public interest' which they define as providing public goods, that is non-excludable goods available to all, such as roads or clean air, and enforcing the rules of contract and fair competition which underline a free market....; this critique... differs from the countervailing theory which encourages governments to intervene on behalf of weak sectional interests as well as the public interest...; countervailing theory recognises the legitimacy of sectional interests groups but requires that all sectional interests, as well as the public interest, should have a fair share of political influence...; neo-liberalism ..rejects the legitimacy of any sectional pressure on

government and confines the role of government to protecting the public interest' (Gold 1991,p.526).

The Environmental Revolution

I examine this case as it is based more on the conflict of ideas rather than transfers of wealth. During the mid 1980s the government departments concerned with natural resources were re-organised by the incoming labour government. The environmental lobby was concerned to separate the policy making functions of the departments from their role as trading departments. They believed that the environmental interest was subservient to the trading interest. The labour government was prepared to listen. The Treasury sided with the environmentalists presumably to seek a reduction in the power base of the respective departments and also to reduce the fiscal drain on government resources. The only opposition came from the departments themselves!

Through the latter years of the labour government resource law was extensively reviewed and a draft Resource Management Bill prepared. The national government reviewed the bill and eventually had it passed in mid 1991. In this case there was extensive consultation with the environmental lobby and wider local administration groups as they would have to administer the Act. The environmentalists succeeded in getting a very strong bottom line ethic into the Act (clause 5(2)), but were not successful in getting additional restrictions on the mining lobby. The implications for farmers of the environmentalist's proposals were not widely canvassed and only now are becoming more widely appreciated. The Treasury influence is shown in a strong underpinning of property right theory in the management of resources which would predispose more market solutions to resource problems than environmentalists would prefer. The strong emphasis on avoiding, remedying or mitigating any adverse effects of activities on the environment also suggests a strong Treasury influence. The implication is that the environmental effects of undertaking an activity should be assessed by the developer. In turn he will have to show who is going to bear the costs of mitigating such effects. This is the nearest the Act gets to identifying user or polluter pays.

This case shows that pressure groups operate in the area of ideas as well as in terms of transfers of wealth. Their objectives can be achieved by the same kind of processes in both instances. The environmental groups use the media, they approach politicians, they sidle up to bureaucrats, and they develop a constituency which turns out to be difficult to withstand. When success is achieved they then infiltrate the very government bodies that previously held them at bay!

In general, this case demonstrates that criteria based on wealth transfers alone are too narrow for an explanatory model of government decision making and that a wider political model of the system should be sought. This can be found in the work of Lowi

(1972), and Olson (1965) and others which I have discussed elsewhere (Johnson 1994).

Pressure and the Bureaucracy

The basic model holds that bureaucrats are empire builders and dominated by self-interest. This is expressed in such objectives as maximising their budgets and improving their conditions of service. In New Zealand it has surfaced as an apparent rigidity to change and an unwillingness to take new governments seriously. It has also surfaced as departments becoming too big in relation to others and their activities have been difficult to control. As a result of these perceptions, the labour government put great effort into the State Sector Act and the Public Finance Act so as to achieve a weakening of the power of departments and greater control from the elected representatives. It is not clear whether they were driven by the precepts of public choice theory or just had bitter memories of the first months of the 1972-75 period of government!

I believe that the bureaucracy does have a key role in the decision making process but that this lies elsewhere to the above. It is the information role that is important (see diagram) for a number of reasons. First, matters are too complex for decision makers at the political level to take everything on board. Second, experts have to be employed in their various fields. Third, information has to be gathered and processed. Fourth, some balance or sense has to be exuded out of the information and pressures that are generated around the politicians. Fifth, departments are the repository or corporate memory of past policy decisions. It is a separate matter whether the state needs to administer all the programmes past and present politicians have created. As is well recognised, there is no compulsive reason for the state to be involved in many programmes and the modern tendency is to create SOEs or privatise as many of these former government services as possible.

There is then a core bureaucracy that is needed to run the modern state and its influence will be reflected in the quality of the programmes put forward and the background analysis it undertakes. The public choice model (and experience) suggests that it will need to listen to the pressure groups of whatever sort to do this core job properly. It will arbitrate between different points of view but will be subservient to political requirements. A current weakness may be that this key role will be made subservient to the contractual situation between Minister and chief executive. It seems that the typical department needs to be quite clear what it believes its primary goals are and be able to hold to them when under pressure.

The New Zealand public service is built on the principle of neutrality. Advice to Ministers should be able to be made on a free and non-partisan basis. Policies, once decided, should be administered faithfully and as efficiently as possible. This independence has already been weakened by the State Sector Act with its contract system for chief executives with Ministers of

the day, and could be weakened further by the introduction of MMP. At election time there would be a considerable period while coalitions were sorted out when the bureaucracy would have no part to play. Once a government was formed coalition partners would want access to public service policy advice on an equal footing. Minor parties in a coalition might want a junior finance minister or at least access to the information and quality advice that Treasury provides. Indeed how could a budget be formulated without consulting the minor parties? In putting up legislation, a broad range of parties may need briefing from civil servants if coalitions are changing.

Another departure could be different coalition ministers following different agendas through their departments. There could be a weakening of the collective responsibility of the coalition government. Departments would find themselves estranged from other departments and also responsible for carrying and presenting individual agendas to Cabinet. Some would say we are already well down this path since the system of officials committees was abandoned in the 1980s.

A different threat to departments is that of amalgamation. It has been suggested that there could be only four departments by the year 2010 compared with the 30 or so now. Underlying this would be an increased drive to privatisation especially in health, education, energy and broadcasting. There would be left a Department of Services, a Department for Positive and Negative Taxation, a Department of Social Services, and a Department of Quality Assurance. Each department would have three ministers as a board answerable to Parliament. As a result the tax revenue could be reduced to around 25 percent of GDP instead of the current 37 percent. This proposal would certainly help solve the coordination issue though the pressure at the top could be rather fantastic. However, entrenched interests in each mega-corporate may make coordination an extremely drawn out and costly process.

It has been suggested that a new department of coordination would be required under MMP. Public servants could continue to stand apart and give free and frank advice while a new body dealt with the compromises, the massaging of information, and the final advice to ministers. This sounds like an enhanced Prime Minister's office to me though it could take the form of enhanced ministerial suites or a new stand-alone body! Enhanced ministerial suites would be the death to some departments as they would lose control of the information and advice process so we can expect some opposition to this outcome. Alternatively, ministerial suites could be placed in departments as in the United Kingdom.

The Political Nexus

A strand of the public choice paradigm is that politicians should be more responsible to their constituencies so that the rights of the individual are protected. Reform is needed to make sure that voting procedures, party systems and policy making are more responsive to the groups who represent and are willing to protect individual rights. In New Zealand the needs of individuals and

groups seem to be forgotten between elections. We have first-past-the-post elections, a one-house parliament, a cabinet system of government and (previously) a disregard for promises made and groups represented. As far as the public is concerned, there is a general distrust of all people who take part in the process.

And yet at the same time we have a diminution of pressure group activity compared to other countries and a relative freedom from political appointments to the senior public service and state agencies!

Also, the focus on the national interest is fairly well preserved by present systems and could be said to serve the public quite well.

And yet the public have voted in two referendums for a change to the system. The two-stage procedure certainly looked curious. The first referendum asked whether the voters wished to change the system and offered a choice of four options: supplementary member, single transferable vote, mixed member proportional and preferential voting. A large majority voted for change (85 percent) and a clear preference was shown for mixed member proportional representation (71 percent). The second referendum offered the choice of first-past-the-post (FPP) and mixed member proportional representation (MMP). That the public chose MMP with its candidate lists and enlarged single house either indicates a total ignorance of how politics works or they so distrusted the present crop of politicians that they voted for change anyway on the basis that anything else must be better!

The MMP system will certainly bring about changes to the electorate system, the selection of candidates, the balance of power in the house, the selection of cabinet and others. These changes are not discussed here. What I want to do is to reflect back on the triangular relationship posed at the beginning of this paper and discuss how MMP will affect these.

It is not inevitable that no one party will get an outright majority. However, it has been postulated that coalition governments would only be likely to reach agreement on issues with compromise on all sides. As a broad range of views will be presented, interest group pressure would have to be applied across the board to be effective. Information provision would have to be treated likewise. It is conceivable that pressure group activity may have to extend backwards into the party groups. This would give them some say in party manifestoes (if such are to continue). Political donations would have to be more evenly spread among the parties particularly as the outcome of elections could become more uncertain. This all assumes coalitions are inevitable.

Representation at the regional level will change. The reduction of electorates will see larger areas in each electorate and more impersonal representation. List candidates will not represent any particular area at all. The dual vote system suggests that two teams will be formed—one that concentrates on national policy matters and the other on electorate policy (will they have the

same pay?). This then raises a bit of a conundrum as to what electorate policy is? It has to be something in order for electoral seat holders to be re-elected. Morgan suggest (NBR May 9) that a contest will ensue between local government structures and electorate oriented political parties as to whose domain it is. Would some form of electorate government replace local government? Would the central political parties need to invade the local government parties? As it stands at present the vote going to the electorate member is largely wasted except to make up numbers in the lobbies at the centre. Morgan goes on to say that the whole concept of electorate representation can be done away with under MMP. Indeed it is interesting that in South Africa an election has been held with no electorates at all but only lists classified by parties.

What of environmental issues? Here I believe the lobby groups will need to have a double pronged information policy aimed at both the elected members and the public. Decisions at the centre will be muted except in circumstances where there is a clear lead in public opinion. In some countries environmental parties have contested elections and in some cases have held the balance of power in coalitions. In New Zealand these forces are submerged in the Alliance at present but could well separate out under pressure.

On economic issues, much depends on the ongoing course of disengagement of governments from the economy. Recent developments in New Zealand have reduced the power of the lobbyists as there is less government intervention to create rent-seeking situations. The days of import licensing are long gone though presumably there is some lobby that benefits from floating exchange rates, managed interest rates and inflation rates, and privatisation policies.

Scrimgeour and Pasour (1994) maintain there are still three areas in agricultural policy where significant distortions continue to exist. They refer to price distortion in marketing boards, private benefits masquerading as public benefits in R & D, and the moral hazard effects of disaster relief. They maintain that there are significant gains from further deregulation as these policies impose considerable costs on the economy. But because it is not possible to clearly identify a significant group of beneficiaries, and opposition to change is very vocal from the groups likely to be affected, the urge to reform has diminished. They maintain it is important to provide information about winners and losers and the benefits of change.

On social issues, there is plenty to discuss. Powerful lobbies exist in health, education and social welfare. Professional groups have a great deal to say about matters that affect them. Yet all along the government seems to take an altruistic view of the social problems of the day doing its best with the resources that society is prepared to yield up to to it to do the job. It seems unlikely to me that any particular group gains significantly from the present mix of policies.

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**Measuring Efficiency with Stochastic Frontier Production Function Approach: An
Application to Rubber Estates in Sri Lanka**

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**Measuring Efficiency with Stochastic Frontier Production Function Approach: An
Application to Rubber Estates in Sri Lanka**

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Abstract

This study examines the farm-specific technical efficiency and identifies the factors which influence inefficiency of rubber production by estates in Sri Lanka. A time-varying stochastic frontier production model for unbalanced panel data is estimated for 32 estates using maximum-likelihood estimates to predict technical efficiency for each estate. These predicted technical efficiency effects are then related to estate-specific factors using ordinary least squares regression. Results suggest that most of the rubber estates in Sri Lanka operate near the production frontier and technical efficiency has not changed over time. The estate size, tapping days, rainfall and soil factors were identified as factors which influence inefficiency.

Key words: Stochastic frontier, technical efficiency, maximum-likelihood estimates

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1. Introduction

In microeconomic theory a production function is defined in terms of maximum output that can be produced from a specified set of inputs, given the existing technology available to the firms involved. The estimation of this production function is usually done by traditional least squares methods. The least squares regression methods measure mean production rather than maximum production. Therefore, the estimated production could be described as average production.

The seminal work by Farrell(1957) introduced a methodology to measure maximum production rather than average production using production frontiers which also measure technical efficiency. Since then economists have proposed several econometric methods to estimate frontier production functions. The recent work by Battese and Coelli(1992) developed an econometric model to estimate time-varying technical efficiency for panel data. This paper applies the Battese and Coelli model to study the technical efficiency of a sample of state-owned rubber estates in Sri Lanka.

Since 1977 the Sri Lankan government has undertaken various economic reforms and is considering further reforms towards an open-market economy. The agricultural sector is seen as a potentially leading sector in these reforms because of its important contribution to both employment and output. The agricultural sector employs about 45 percent of the labour force and accounts for 26 percent of GDP. The tree crops of tea, rubber and coconut are the main agricultural products and they earn foreign exchange for the economy.

The rubber industry of Sri Lanka is the second largest tree crop industry after tea, produces about 120 million kgs and exports 80 percent of its production. This industry comprises two sectors: a state owned estate sector(more than 40 ha) and a smallholding sector.

The question is whether the rubber industry operates at a sufficient level of technical efficiency to justify its future survival given economic reforms. Given the importance of the rubber industry to the agricultural sector and to the economy this is an important issue.

It is difficult to answer this question without having knowledge of the existing level of technical efficiency of the Sri Lankan rubber industry. In the Sri Lankan rubber industry, the state-owned estate sector represents 44 percent of rubber land area and produces 35 percent of total production, hence it plays an important role in total rubber production. The objectives of this study are to measure mean technical efficiency of rubber estates, to measure estate-specific technical efficiency and identify factors influencing technical inefficiency.

This paper is set out following way. Section 2 discusses the measurement of efficiency and explains the stochastic production function approach. The econometric model is described in section 3 with special reference to a time-varying farm-specific model. The data and the empirical model are discussed in section 4 while section 5 discusses the empirical results. The paper ends with a summary and conclusion.

2. Measurement of efficiency

The current interest in efficiency measurement originated from the pioneering study by Farrell(1957) where total efficiency was decomposed into technical and allocative efficiency. Technical efficiency refers to the capacity of producing the maximum level of output for a given quantity of inputs and technology. Consider a firm that uses n inputs $X = (X_1, \dots, X_n)$ to produce a single output Y . The firm's technology is characterised by the production function $f(X)$, which shows the maximum output obtainable from various input vectors. If a firm produces Y^0 level of output using inputs X^0 , it is said to be technically efficient if $Y^0 = f(X^0)$ and technically inefficient if $Y^0 < f(X^0)$. Thus, the technical efficiency is measured in terms of a relationship between actual output to the frontier output.

The historical progress of adoption of econometric models to study technical efficiency has been from deterministic frontiers(Aigner and Chu; Afriat), to stochastic frontiers (Aigner, Lovell and Schmidt; Meeusen and van den Broek) to stochastic panel-data models(Pitt and Lee; Battese and Coelli). More recent studies(Schmidt and Sickles; Cornwell et al; Kumbhakar; Battese and Coelli) have introduced econometric models to study firm-specific efficiency effects over time.

Many authors have altered and generalised the original specification of the stochastic frontier production function and thorough reviews of this literature are given by Schmidt(1986), Baur(1990) and Battese(1992). In more recent studies, attention has been given to panel-data models.

The recent time-varying stochastic frontiers are based on the concept of a stochastic frontier production function independently proposed by Aigner, Lovell and Schmidt(1977) and Meeusen and van den Broek(1977) and given by

$$(1) \quad Y_{it} = f(X_{it}; \beta) \exp^{e_{it}}$$

$$e_{it} = v_{it} - u_{it} \quad i=1, \dots, N; t=1, \dots, T$$

Where Y_{it} represents the production for the i -th firm at the t -th period of observation; $f(X_{it}; \beta)$ is a suitable function of a vector, X_{it} , of factor inputs associated with the production of the i -th firm in the t -th period of observation; β 's are unknown parameters; e_{it} is an error term composed of two independent terms v_{it} and u_{it} ; the v_{it} is assumed to be an independent and identically distributed $N(0, \sigma_v^2)$ random error; u_{it} is assumed to be independent and identically distributed non-negative truncation of the $N(\mu, \sigma^2)$ distribution and is associated with technical efficiency.

Battese and Coelli(1992) re-specified the stochastic frontier model given above to indicate a simple exponential specification of time-varying farm efficiency effects in an unbalanced panel data set. They applied this model to a sample of fifteen paddy farmers in an Indian village. In this study we consider this general model to predict the technical efficiencies of a sample of rubber estates in Sri Lanka. By imposing different restrictions on the Battese and Coelli model, a variety of alternative models may be derived and estimated. This is important as the prediction of efficiency effects depend on the specification of distributional assumptions. A 'top-down' sequential testing procedure was followed to select the most data-consistent appropriate model from the above alternative models. Once the appropriate model was chosen the technical efficiencies were predicted using the selected model. Finally, predicted technical efficiency values were related to farm-specific factors to identify factors which influence inefficiency.

3. Econometric model

We consider the following stochastic frontier production function with Cobb-Douglas functional form as specified by Battese and Coelli(1992)

$$(2) \quad \ln y_{it} = \beta_0 + \sum_{j=1}^K \beta_j \ln x_{ijt} + v_{it} - u_{it}$$

$$u_{it} = \eta_i u_i = \{ \exp[-\eta(t-T)] \} u_i \\ i = 1, 2, \dots, N; t = 1, 2, \dots, T.$$

where y_{it} is the output produced from the i -th firm at the t -th period of time; x_{ijt} is the amount of j -th input used by i -th firm at the t -th time period; β_j is the unknown parameter for j -th input; v_{it} is stochastic error component with zero mean and constant variance; u_{it} is the non-negative random variable associated with the technical efficiency; and η is an unknown scalar parameter.

We also consider the Battese and Corra(1977) parameterisation and define $\sigma_s^2 = \sigma^2 + \sigma_v^2$ and $\gamma = \sigma^2 / (\sigma^2 + \sigma_v^2)$ where γ is restricted to lie between zero and one.

By writing the conditional density function for u_i given $(v_{it} - u_{it})$ for model (2), the minimum-mean-squared-error predictor of the technical efficiency of the i -th firm at the t -th time period is obtained (Battese and Coelli, 1992) and given by

$$(3) \quad E[\exp(-U_i(v_{it} - u_{it}))] = \left\{ \frac{1 - \phi[\eta_i \sigma_i^* - (\mu_i^* / \sigma_i^*)]}{1 - \phi(-\mu_i^* / \sigma_i^*)} \right\} \exp \left[-\eta_i \mu_i^* + \frac{1}{2} \eta_i^2 \sigma_i^{*2} \right]$$

where

$$\mu_i^* = \frac{\mu \sigma_v^2 - \eta_i / E_i \sigma^2}{\sigma_v^2 + \eta_i / \eta_i \sigma^2}$$

$$\sigma_i^{*2} = \frac{\sigma_v^2 \sigma^2}{\sigma_v^2 + \eta_i' \eta_i \sigma^2}$$

Where η_i represents the $(T_i \times 1)$ vector of η_{it} parameter(s) associated with the time periods observed for the i -th firm and $\phi(\cdot)$ represents the distribution function for the standard normal distribution.

According to Battese and Coelli (1992), the mean technical efficiency of firms at the t -th time period is given by

$$(4) \quad TE_t = E[\exp(-\eta_t U_t)], \text{ where } \eta_t = \exp[-\eta(t-T)]$$

This is obtained by straightforward integration with the density function of U_i and is given by

$$(5) \quad TE_t = \frac{1 - \phi[\eta_t \sigma - (\mu/\sigma)]}{1 - \phi(-\mu/\sigma)} \exp[-\eta_t \mu - \frac{1}{2} \eta_t^2 \sigma^2]$$

As mentioned above this Battese and Coelli time-varying model could be considered as a more general model for the estimation of technical efficiencies. By imposing restrictions on u_i and the parameters η , μ and γ , alternative models specified by previous researchers can be obtained as shown in table 1.

Table 1: Specification of models for estimation of technical efficiency for Sri Lankan rubber estates.

Model	Restrictions γ, η, μ	Distribution of u_i	Descriptions
Model 1		$u_i \sim N(\mu, \sigma_u^2) $	efficiency effects are time variant and arise from a general truncation of the normal distribution.
Model 2	$\mu = 0$	$u_i \sim N(0, \sigma_u^2) $	efficiency effects are time variant and have a half-normal distribution.
Model 3	$\eta = \mu = 0$	$u_i \sim N(0, \sigma_u^2) $	efficiency effects are time invariant and have a half-normal distribution.
Model 4	$\gamma = \eta = \mu = 0$	$u_i = 0$	no efficiency effects.

MODEL 1 - This is the completely unrestricted model where all parameters are estimated along with the β parameters, $\sigma_s^2 = \sigma_v^2 + \sigma^2$, $\gamma = \sigma^2 / \sigma_s^2$, μ , η . It is the stochastic frontier production function in which the firm effects U_{it} have the time-varying structure (ie., η is an unknown parameter and the U_i 's are a non-negative truncation of the $N(\mu, \sigma^2)$ distribution. This is the Battese and Coelli (1992) model.

MODEL 2 restricts $\mu = 0$ meaning that u_i has a half-normal (versus truncated-normal) distribution but efficiency effects may be time-varying.

MODEL 3 restricts $\mu = \eta = 0$ so that efficiency effects are time-invariant and have a half-normal distribution for u_i . Pitt and Lee (1981) derived this model for the half-normal case.

MODEL 4 restricts $\gamma = \mu = \eta = 0$ so that there are no efficiency effects. This is the traditional average-response function.

The advantage of the Battese and Coelli (1992) model is that if $\eta > 0$, then as t increases (ie., as $t < T$), u_{it} (or e^{it}) monotonically decreases. That means that as the firm proceeds over time, its inefficiency level monotonically decreases and the firm proceeds towards the frontier. Similarly, if $\eta < 0$, inefficiency increases over time. Therefore the testable hypothesis offered by the model is that efficiency monotonically decreases or increases over time. However, the hypothesis of fluctuating efficiency can not be tested in this model.

Model 4 may be estimated by the standard OLS procedure. Models 1-3 involve distributional assumptions regarding the error term ($v_{it}-u_{it}$). These models may be estimated using a Maximum Likelihood Estimator to obtain relevant coefficient values and the corresponding technical efficiencies. The computer programme FRONTIER version 3.1 is used to estimate these models.

Given the general formulation of the four models, the next question is how to select the appropriate model in a particular empirical context. This can be done through a sequence of nested likelihood-ratio tests on the efficiency parameters (γ, μ and η).

Once farm/firm level efficiency effects are predicted, as a second step the factors influencing farm/firm-level efficiency can be examined. This approach is first attempted by Kalirajan(1981) and Pitt and Lee(1981). It involves two stages. The first stage involves the estimation of a stochastic frontier production function and the prediction of farm-level technical efficiency effects. In the second stage, these predicted technical efficiency effects are related to farm-specific factors using least squares regression.

4. Data and empirical models

Based on prior knowledge and a review of relevant literature, sample observations from 32 estates from two major rubber growing districts were obtained for the years 1986, 1987, 1990 and 1991 for the following variables: yield, harvesting area, trees in tapping, age of trees, harvesting labour, management, maintenance labour, tapping days, rainfall,

cost of transport, cost of fertiliser, and soil types. It was hypothesised that technical efficiency could be 'explained' as follows:

$$\ln Y = f(\text{harvesting area, trees in tapping, age of trees, harvesting labour, management}).$$

However, due to collinearity between trees in tapping and age of trees, these two variables were combined to form a new variable WTrees giving the following unrestricted specification of the stochastic frontier model corresponding to Model 1 in Table 1.

$$(6) \ln y_{it} = \beta_0 + \beta_1 \ln(\text{WTrees}) + \beta_2 \ln(\text{HLab}) + \beta_3 \ln(\text{Mgmt}) + v_{it} - u_{it}, \\ i=1, \dots, N; t=1, \dots, T.$$

where y is rubber output measured in kilograms; WTrees are the trees which are in tapping weighted according to age groups; HLab is the labour used in harvesting activities measured in eight-hour man-days; Mgmt is a proxy variable used to measure management; v_{it} is the stochastic random error; and u_{it} is the negative random variable associated with the technical efficiency.

In stage 2, an attempt was made to account for the technical efficiency results obtained from stage 1 by estimating the following model:

$$(7) \text{PTE}_{it} = \alpha + g_1(\text{Harea})_{it} + g_2(\text{days})_{it} + g_3(\text{rainfall})_{it} + g_4(\text{soil})_{it} + w_{it}$$

where PTE_{it} is the predicted technical efficiency from the stage 1 model; Harea is the harvesting area in hectares; days are tapping days; rainfall measured in millimetres; soil is a dummy variable for Agalawatta series soils; and w_{it} is the error term. The empirical results obtained in each of these two steps are discussed in section 5.

5. Empirical results

As indicated in Table 1, three restricted versions of model 1 can be obtained by placing various restrictions on the efficiency parameters (γ, η and μ). The relevant Maximum Likelihood results for each of the four specifications are presented in Table 2, where model 1 is the unrestricted model and models 2 to 4 are the restricted versions.

Table 2: Maximum likelihood results for the four models

Variables	Parameters	Model			
		1	3	4	5
Constant	β_0	1.704 (0.158)	1.590 (0.160)	1.612 (0.145)	1.490 (0.107)
ln(WTrees)	β_1	0.542 (0.133)	0.519 (0.152)	0.523 (0.057)	0.509 (0.051)
ln(Hlab)	β_2	0.428 (0.120)	0.460 (0.174)	0.452 (0.066)	0.479 (0.057)
ln(Mgmt)	β_3	0.157 (0.301)	0.159 (0.239)	0.161 (0.053)	0.158 (0.051)
	σ_s^2	0.016 (0.008)	0.021 (0.019)	0.022 (0.005)	0.016
	γ	0.241 (0.185)	0.375 (0.772)	0.409 (0.185)	0
	μ	0.159 (0.104)	0	0	0
	η	-0.012 (0.510)	0.003 (0.895)	0	0
Log-likelihood values		85.20	83.69	83.67	81.40

The estimated asymptotic standard errors are in parentheses.

The entries in the first four rows of Table 2 show that the values of the β_j do not vary appreciably across the four models. Moreover, all of these 16 coefficients are statistically significant except for β_3 in model 2. The β_j s represent elasticity coefficients, all of which are of reasonable magnitude. However, the interest here is in testing for significant differences amongst the models in regards to the efficiency parameters (γ, μ and η). The results of the Likelihood Ratio tests on these efficiency parameters are presented in Table 3.

Table 3: Likelihood ratio tests on efficiency parameters

Models compared	Ho	LR tests statistics (χ^2)	P-value	Decision(5%)
2 vs 1	$\mu=0$	3.02	0.082	Do not reject Ho
3 vs 2	$\eta=0 \mu=0$	0.04	0.841	Do not reject Ho
4 vs 3	$\gamma=0 \eta=\mu=0$	4.52	0.034	Reject Ho

The Likelihood Ratio test results show that at a 5 percent significance level, only model 4 is rejected against Model 3. This suggest that Model 3 (u_i is half-normal and time-invariant efficiency effects) is the most consistent with the sample data and , consequently, will be used to predict the estate-specific and mean efficiency levels. It is interesting to note that at a 1 percent significance level, the LR tests indicate that Model 4 (no technical efficiency parameters involved in the model) would be the most data consistent specification.

Using Model 3 as the preferred frontier production function, the total output elasticity coefficient is 1.136 which indicates slightly increasing returns to scale. A likelihood-ratio test rejected the hypothesis of constant returns to scale (P-value = 0.0006). In comparison, a similar study by Tran *et al* for rubber estates in Vietnam estimated the return-to-scale parameter at 1.054 which is lower than in this study.

Predictions of the technical efficiencies of the thirty two Sri Lankan rubber estates using the predictor defined by Battese and Coelli(1992) are presented in Table 4. These predicted values range from 86.9 percent to 97.8 percent with a mean value of 92.7 percent. Seventy eight percent of the estates are in the 0.9 to 1 efficiency range and the rest are in 0.8 to 0.9 efficiency range. This suggests that the overall level of technical efficiency is high in Sri Lankan rubber estates. This could be justifiable because the rubber production technologies in Sri Lanka are recognised as high and similar across rubber estates in Sri Lanka (Barlow and Peries, 1977).

These predicted technical efficiency values are then related to farm specific input factors

and factors which are left out from efficiency model using OLS. The results are given in Table 5.

Table 4: Predicted technical efficiency estimates for 32 rubber estates in Sri Lanka.

Estate number	Technical efficiency
1	0.907
2	0.966
3	0.909
4	0.872
5	0.903
6	0.910
7	0.871
8	0.879
9	0.936
10	0.978
11	0.964
12	0.962
13	0.923
14	0.977
15	0.894
16	0.892
17	0.935
18	0.955
19	0.910
20	0.944
21	0.885
22	0.946
23	0.910
24	0.907
25	0.869
26	0.921
27	0.958
28	0.968
29	0.963
30	0.916
31	0.943
32	0.976
Mean	0.927

Table 5: Regression of predicted technical efficiencies on farm specific factors.

Variable	Coefficient
Constant	0.8991
Harvesting area	0.0008 (0.0002)
Days in tapping	0.00014 (0.00008)
Rainfall	-0.000008 (0.000002)
Soil type	-0.0395 (0.0055)

The estimated standard errors are in parentheses. Adjusted $R^2 = 0.34$

The results in Table 5 suggest that the inefficiency in rubber estates is associated with size (estate area), number of days in tapping, annual rainfall and soil factor. However, all the coefficients of the above variables are very small and hence little can be done by improving these factors. The harvesting area could be increased by increasing the ratio between mature area to immature area or by increasing total estate area. The estate areas could not be increased because almost all the land suitable for rubber is being already used and areas surrounding the estates are occupied by villagers. The way of increasing area is by planting rubber in other areas where land is available (this is under investigation at the moment) or by amalgamating adjoining estates under one management. The days in tapping and rainfall (rainy days) are always inversely related to each other and rainfall, of course, can not be controlled. However, the number of days could be increased by introducing appropriate techniques (eg, Rain-guard). When we consider soil factors of Agalawatta series, shifting rubber from these soils to other rubber-growing soils could increase efficiency a little. However, this is also impossible because of limited land availability.

6. Conclusion

A firm-specific stochastic frontier production function with time varying effects was applied to a sample of rubber estates in Sri Lanka to examine their technical efficiencies and the factors which influence inefficiency. The results reveal that all Sri Lankan rubber estates operate closer to the frontier yielding a mean predicted efficiency of 93 percent and efficiency has not changed over time. The second stage of analysis showed that 7 percent inefficiency is due to estate size, number of tapping days, annual rainfall and soil factors.

These results indicate that the rubber industry is technically efficient to withstand the ongoing economic reforms in Sri Lanka. However, whether these estates are allocatively efficient or not is a question beyond the scope of our present research. This question will be investigated in a future research project.

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PATENTING GENETICALLY MODIFIED ORGANISMS: THE CASE AGAINST
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Abstract

Patents are a social contract designed to bring inventions into the public domain by offering a limited monopoly to the inventor. Recent technological developments cast doubt on the wisdom of patenting. A different form of social contract is called for. Under current patent law patents should not be made available to genetically modified organisms because they imply the danger of increasing genetic uniformity if the new organisms are applied on a large scale. A different form of social contract for the registration and supervision of biodiversity is proposed.

Keywords: patent law, genetically modified organisms, uncertainty, biodiversity

INTRODUCTION

Patents are state-supported monopolies and as such are a form of property right with an expiry date. They are issued in order to provide the developer of an industrial invention with the means and the time to organise the production and marketing of the new product and, thus, to recoup some of the costs spent on the development of the invention. The traditional reason for patents is that if patents were not available, inventors' ideas would be used by firms and the inventor would get nothing. Traditionally, therefore, patents are seen as an important well-spring of innovation and Research and Development

This paper argues that patents for industrial products are an instrument to reduce some of the uncertainty associated with technical innovation, but as such are losing their effectiveness as a result of technological changes. A different social contract is called for.

In recent years there has been some considerable debate about the issue of extending industrial patent right to genetically modified organisms, be it plants or animals. The thesis of this paper is that such use of the patenting system would have the effect of increasing rather than diminishing uncertainty. The basic argument rests on the consideration that industrial patents involve inorganic materials or dead organic substances and that, therefore, the inventions concerned tend to reduce entropy.

By contrast, in the organic kingdoms of plants and animals the second law of thermodynamics does not apply. In these realms, the operative words are differentiation and diversity. By introducing genetically uniform plants and animals this diversity is threatened and thereby the eventual effects of the patented inventions are highly uncertain and even dangerous (Schuurman, 1994).

It is important to distinguish between inventions and innovations. The former occur all the time. The latter are based upon inventions and tend to occur in swarms. The basic idea of the Kondratieff cycle is that clusters of innovations initiate a new business expansion. At present, new clusters of innovations based upon microprocessors, new materials and biotechnology are appearing and may start a new Kondratieff (Keus)

The paper concludes by examining alternative ways of alleviating the uncertainties involved in the use of genetically modified organisms.

PATENTS AS INSTRUMENTS TO REDUCE UNCERTAINTY

Patents have been available for many centuries. They are the strongest form of property right known to English law. A patent is a State-supported monopoly with a sunset clause (Hammond, 1989, p. 12). Its function is to provide an inventor the opportunity to develop an innovation by setting up the necessary manufacturing equipment and processes. The patent would enable him or her to do this without being subject to cut-throat competition from those able to imitate the invention which may have cost a fortune in terms of time and money to develop. English law used to provide a timespan of 14 (now 16) years for a patent, that is twice the normal length of an apprenticeship of 7 years in the early 17th century on the reasoning that this would be sufficient to set up a new industrial activity (Grace, p. 2).

Patents are not issued for discoveries. The distinction between discovery and invention has important economic implications. Once an invention occurs, knowledge exists. The costs of reproducing that knowledge are tiny compared with the costs of discovery. Hence, there are economies of scale as soon as the knowledge is made available. It would be relatively easy for firms to "free ride" on the work of others by taking advantage of their knowledge. In effect, patent law allows for the "privatisation" or "internalising" of the benefits of an invention which might otherwise be expropriated by others. In other words, it prevents others from "free riding" on the work of inventors by granting a completely "free ride" to inventors for a substantial time. By this process, the possibility of one free ride is replaced by the certainty of another. Such a course may well be sub-optimal.

It should be emphasised that a patent is a form of industrial property. It is a licence to exploit an invention for profit. It is not a matter of intellectual property. A patent is granted only if the invention is novel; involves manufacture and is useful. These three criteria mean that the overwhelming majority of patents are granted for manufactures. Discoveries as such are not patentable.

In recent years, after some struggle, patents have been issued for biological matters such as the injection of enzymes into a beast just prior to slaughter in order to provide meat of improved quality or for methods of cultivating micro-organisms for anti-biotic production (Grace, p. 50).

Patents should be for something which is useful. The test for this is:

"whether the invention will achieve that which the specification sets out that it will achieve, in the technical or practical sense that is, not in the commercial sense." (Grace, p. 59).

Indeed, it is by means of making technical inventions that mankind has been able to fashion an enormously large and varied range of instruments and processes which are designed to make life not only pleasant and worthwhile but which also enable the husbandry of plants and animals for the purpose of food production and processing.

By means of technical operators (machines, tools, instruments, but also chemical reactor vats) energy flows can be directed towards the attainment of useful purposes.

It is for this reason that technical innovations will always have a large element of surprise. Often when a new technical operator is invented, patented and produced, neither the original inventor(s) nor those who first make use of the new operator will be able to have a complete

idea as to the whole field of new applications made possible. This is particularly true for inventions such as the transistor, the computer, the laser, the steam engine and the combustion engine. The dynamics engendered by the application of innovations are unknown or even unknowable.

In this connection Nef (quoted by De Jong) has drawn attention to the rationale for allowing patent monopolies in England in 1624 when the lawmakers decided to remove Government monopolies. It was, in part, the self-interest of the business tycoons of these days who needed the inventions and, in part, a change in intellectual climate in which the promotion of science and its applications was emphasised for the sake of "the multiplication of material conveniences". It was in those days that the mechanisation of the Western view of the world took shape (Dijksterhuis).

The combination of science and technology has indeed given rise to the development of an enormous panoply of instruments, structures and production processes. Until recently, they involved exclusively an interaction between humankind and the material physical world, in particular a use of energy and financial flows to achieve particular ends.

Inventions and Discoveries

Dessauer (quoted by Schuurman, 1972/1980) has drawn a distinction between a pioneering invention and a developmental invention or innovation. The former is an invention in which the creative character, the unexpected, is paramount, even though experimentation, research and thought may have been involved. It is the result of productive technological fantasy. By contrast, the latter rests upon the methodical labour of a number of engineers and inventors and thus upon technological science. It is carried out step by step, according to a work schedule or design. Despite efforts to describe the personality of inventors, the origin of inventions, especially of break-throughs remains a mystery.

Patents may be issued, of course, for each type of invention, provided they comply with the requirements of the patent law such as "novelty" and "inventive step" and "usefulness". Usually the law requires that the invention must be reproducible and must not be obvious to somebody skilled in the art.

Schuurman (1972/1980) has argued that in order to qualify for a patent an invention must involve a new, qualified, general, and integral entity of the technological order of things or facts. The inventor must orient himself or herself in two directions. In the direction of individualisation he must investigate precisely what is and what is not comprehended in the invention. In the opposite direction, the inventor must answer the question whether his invention is perhaps a particularisation of some still more general facet of the order of technology, in which case more new inventions might be possible (Schuurman, 1972/1980, pp. 44,45). In other words, have we got a better mousetrap or have we found a general principle for devising traps, say traps which employ a needle with a quick-working deadly chemical which can be adapted to the trapping of a wide variety of noxious animals (NZ Farmer, 22 June 1994)?

If we are dealing with the former, then often a small firm or individual may have got the spark and the stamina to see something through to the patent stage. Traditionally, it is often thought that the protection of a patent is particularly important for small firms and individuals. By contrast, when we are dealing with a pioneering invention which results in a series of developmental inventions and which require a great deal of expertise and teams of engineers and inventors, then the value of patents is much more dubious, however. Usually, larger

corporations are the vehicles for the development concerned, and such corporations tend to invest large sums into Research and Development as a matter of course. Since the key movers and shakers would be keen to publish their research in learned journals and books, the probability that the inventions would be kept secret is not very high. This is not to deny that large corporations can be very effective at keeping knowledge secret.

Modern Technology Differs from Classic Technology

In general terms, technology is a fashioning of things according to a free design on the basis of physics and chemistry. Classic technology made use of natural possibilities (a windmill is a good example). In modern technology nature is dissected according to a scientific plan and then transformed. Thus, it is based upon science and applies scientific methods. In chemistry, invention has been much more difficult than in physics. It usually requires a great deal of experimentation and the results are often very difficult to anticipate. Nevertheless, great advances have been made as witnessed by the development of synthetic materials and more recently in the development of new materials using rare earths.

It should be emphasised that modern technology and science are closely intertwined. Scientific discoveries give rise to the development of new technical instruments and processes. In turn, these new instruments are used by science, often through the research and development departments of business organisations, and so may lead to new discoveries.

Scientific progress in the physical sciences is often achieved by means of experiments. The idea of an experiment is that a small part of reality is set apart or is organised artificially. Thus, reality as given to us is modified in a particular way; it is interrogated in order to provide answers to abstract scientific questions. Such experiments may lead either to pioneering inventions or to developmental inventions. By the time the inventions are at the point where they have become patentable, a long way is likely to have been travelled. When applied in a variety of contexts, the experimental character is indicated by changes in the technical environment which may never have been anticipated by the inventors.

The process of technical inventions leading to new scientific discoveries and these again to new inventions has been described as a spiralling movement over which nobody in particular has any control. Given that pioneering inventions and discoveries lie at the base of such a spiral and determine its windings, this is not surprising. Part of this development is that the research and development work takes place in world-wide networks of universities and transnational companies. These processes result also in changes to the sociology of work and the organisation of markets.

Modern technology has become so pervasive and affects so many facets of life, that society is continually surprised by its effects, including pollution, the accumulation of hazardous wastes and high unemployment. Some of these phenomena may indeed provide a search for new inventions.

Patents As Social Contract

Patents are often described as a social contract (Calhoun, for instance). In exchange for protection over a limited period granted to an individual patentee (often a corporation), society gets access to a new invention once the monopoly expires. Deals can be made for the production of the innovation under license, for example. However, since its origin in the 17th century patent law tends to be confined to the technical aspects of the invention. The wider issues of the invention, when it is widely applied and which may include ethical, environmental

and social issues are not considered by patent offices. The term social contract is, therefore, a pretty narrow one. The period during which the monopoly applies, for instance, is not intended as a trial period for society. It is up to the patentee to make the invention work. The monopoly is of a purely private financial character. Even during the monopoly licensing agreements can be made up, so that production can take place on a wide scale.

Even in a technical sense, however, there are doubts about the wisdom of patents. I have already referred to the propensity to publish on the part of scientists and engineers involved in research and development. In addition, the new technologies of micro-electronics and new materials have changed the way in which production is organised in such a way that the time required to get a patent or a licensing agreement is a stumbling block for high-technology producers.

Wolfgang Streeck (Streeck, p.21) has pointed out that diversified quality production taking place in what used to be called artisan companies in Germany depends on the ability to make alliances and to set up joint ventures with a wide variety of suppliers and internal highly skilled staff. Flexibility, smoothly functioning networks, and timeliness are of the essence in such production systems. Excessive consciousness of property rights may undermine and prevent potentially productive strategic alliances and co-operative relations (Streeck, p. 44). The model for an organisation as described by Streeck is that of an orchestra in which every player is highly qualified and able to play her own part. The conductor is there to beat the time and implement the score.

Moreover, with the now widespread use of computer equipment in design and engineering, it seems somewhat odd to require detailed drawings and descriptions of an invention. If a computer programme is used in the design, then users of the invention would be able to adapt the invention in all sorts of ways at the push of a button.

Especially by means of imitation technical knowledge is being diffused at ever greater speeds (Wemelsfelder).

Perhaps the time has come to reconsider the merits of patent law and other forms of intellectual property rights as social contracts and to devise a social contract pertaining to knowledge, inventions and the dissemination of the same which is more in tune with the developments of the 20th century. The question how such a contract would deal with the uncertainties arising from new discoveries and developments should be very carefully considered. A registration system which describes the invention, details the inventors and possible range of applications similar to copyright might suffice. If this is linked up with an Industrial Council for supervision to ensure that the system works properly and which monitors the use of registered inventions, so that unexpected and possibly adverse developments may be anticipated, a more wide-ranging social contract could be shaped.

BIOTECHNOLOGY

Since the discovery of DNA, molecular biology has been developing very rapidly. Molecular biology uses a particular experimental method in order to learn more about the structure and the properties of the DNA molecule of various organisms. Little bits of the DNA molecule of a certain species are transferred into the DNA molecule of a bacterium. That bacterium is then "enriched" or "crippled" by the foreign DNA. Naturally, one selects only bacteria which are healthy and harmless to people, animals and plants and environment. Bacteria are used because they reproduce rapidly, so that they can produce large quantities of the isolated piece

of DNA and the substance for which that DNA is responsible. In this way it has become possible to manipulate genetic information by taking components of the genetic information of higher species and transferring them into lower species such as bacteria or fungi.

Gasser and Fraley have pointed out that:

"In the laboratory, plants can now be made to withstand insects, viruses and herbicides. Fruits can be made to resist spoilage, and grains may become more nutritious and economical (Gasser and Fraley, p. 34).

" Still, there are some limitations. In practical terms, genetic engineers can only modify traits expressed by no more than three to five genes. Furthermore, some crops do not respond to current gene-transfer methods, and isolating useful genes is sometimes difficult." (Gasser and Fraley, p.39)

In other words, we are dealing with a technology which is still in its infancy despite the fact that many surprising results have already been obtained. If this is so, then we are dealing with potentially major uncertainties which should be mapped and anticipated in some way. The situation is similar to that of nuclear physics in the 1930s.

PATENT LAW REGARDING BIOTECHNOLOGY

Should an organism modified by means of genetic engineering techniques be patented? New Zealand law in this respect is not yet clearly defined (Calhoun). In 1980 (Calhoun, pp. 60,61) the Assistant Commissioner of Patents issued an official ruling on the patentability of microorganisms. It stated that to be patentable microorganisms had to be the product of a controllable reproducible synthetic process and the product of the process had to be predictable. The ruling stated that claims to microorganisms would not be allowable if the microorganisms occurred in nature or were the product of a non-controllable process, the product of which could not be predicted or predetermined.

To put it in more simple terms the New Zealand Patent Office would issue a patent if the invention involved the transfer of genetic material, claiming as monopoly: the genetic material itself, the transferring vehicle, the method of transferring the genetic material and plant material into which genetic material has been transferred. (Calhoun). However, applications for classical plant breeding processes and products of those processes would be refused.

This ruling has been found to be more restrictive than that of the USA, for instance. Calhoun has given a useful brief summary of international developments, from which the following salient points are taken.

The United States Patent Office has followed a practice of allowing patents for anything under the sun other than humans. Since 1980 (the Chakrabarty decision which allowed a patent on oil-eating bacteria; the Supreme Court ruled that " a patent can be granted on anything under the sun which can be made by man") patents have been granted not only for cells but also for higher life forms such as plants and animals.

The Australian Patent Office has granted patents for biologically pure cultures of discovered microorganisms and for whole plants.

With regard to the nature of inventive step a difficulty which has arisen is that what was not obvious at the time of the application for a patent may be commonplace biotechnology 2 years later. Today many of the basic techniques in recombinant DNA are well established. Nevertheless there may be unexpected practical difficulties encountered in attempting to apply the techniques in specific cases.

An important aspect of patent law is that everybody should be able to use the invention once it moves into the public domain. For this reason the invention and the method of performance must be precisely described. The Australian Patents Act 1952 was amended in 1987 to state that the requirement of fully describing was met by a deposit of a microorganism and by satisfying specific requirements as to the deposit.

It seems likely that the New Zealand law will be amended in due course along the lines suggested by current overseas practices. It is to be hoped that the pros and cons of such changes will receive due consideration in the light of wider considerations than purely legal or commercial interests.

BIODIVERSITY

Difference between Living Organisms and Machines

There is an important distinction between machines and plants and animals. Complicated machines tend to break down often. Given that they are made of very robust materials such as steel and copper, this is a puzzle. Plants, for instance, do not break down in the way a machine does. Yet it works with materials which appear to be anything but strong such as proteins, amino-acids and membranes. What is the nature of the difference? Norbert Wiener, one of the founders of cybernetics (Boiten) introduced the concept of entropy to highlight why a complex apparatus such as a steam engine requires on-going human intervention from outside to keep it going. He did this on the basis of his work on the demon of Maxwell.

"Just as the amount of information in a system is a measure of its degree of organization, so the entropy of a system is a measure of its degree of disorganization; and the one is simply the negative of the other." (Boiten quoted by Wiener).

By virtue of the second law of thermodynamics the amount of information and instructions contained in a steam engine, for instance, degrades to entropy. To keep the machine in working order it must be maintained to ensure that energy in the form of heat can be transformed into mechanical energy. Without maintenance, valves will erode and parts become soiled or burnt through. The engine will only keep working if the entropy in its inside workings is smaller than maximum entropy (i.e. complete order, nothing moves).

Plants too need a structure to keep growing and functioning. The pattern of this structure is contained in the germ cell. The programme for a plant is enclosed in the DNA of the cell nucleus. The genes can be described as the software and the molecular structure of DNA as the hardware. Sexual reproduction changes the programme so that another individual appears. Likewise animals have a genetic code, but by being equipped with a nervous system they have also a learning capability. It is the existence of such a genetic programme in plants and animals which makes for the key difference between physical structures and organisms. It is by means of this programme that the organism generates the information required to maintain its metastable equilibrium. Thus, it reduces entropy and increases the information stored in its textures.

Cybernetics has, of course, attempted to learn from these self-regulating negative feed-back systems in nature to develop automatically working machines.

Living organisms are characterised by differentiation rather than a tendency towards order and uniformity. Even within an organism there is differentiation. Metabolism, for example, is an organised process in which many cells are involved in a wide variety of mutually interdependent ways. Differentiation increases the stability of a plant (Stafleu, p.113). Interestingly, no plant is subject to genetic change. There is hardly anything more stable than the genetic structure and identity of a living organism.

The Importance of Biodiversity

Nevertheless, a plant or an animal is never enclosed within itself, shut off from its environment, as is the case with things. Plants and animals are open systems which enjoy a continuous interaction with their environment.

A population of plants can be said to have a pool of genes. In general every population of plants produces a large number of descendants only a few of which will reach maturity. The genes determine the plant's genotype. Which genotype will survive in a particular environment depends on the phenotype which determines how an individual plant is adapted to its environment. A population can also be described as a reproductive community. Changes in external circumstances can induce major changes in the distribution of genes in the population's pool, in order to enhance the chances of survival.

An ecosystem or biotype (deserts, forests, gardens etc.) denotes a spatially defined set of plants and animals who co-habitat with each other and who are mutually dependent. As such it is always in dynamic equilibrium. A biotype may be opened up by animals or by human intervention.

These basic ideas have proved to be of great significance in the study of biodiversity and biogeography, as outlined by E.O. Wilson (1989). Environmental changes such as deforestation are able to change the number of species in a certain ecosystem very drastically but also very predictably. Once, for example, a habitat is reduced, the rate of extinction of the species living in it depends on the size of the habitat patch left undisturbed and the group of organisms concerned. Models developed by Terborgh and Diamond produced the result that:

"...in patches of between one and 20 square kilometres, a common size for reserves and parks in the tropics and elsewhere, 20 percent or more of the species disappear within 50 years. Some of the birds vanish quickly. Others linger for a while as the "living dead." In regions where the natural habitat is highly fragmented the rate of species loss is even greater." (Wilson, p. 64).

Once a species is extinct, of course, it is gone forever:

"Without diversity there can be no selection (either natural or artificial) for organisms adapted to a particular habitat that then undergoes change. Species diversity-the world's available gene pool-is one of our planet's most important and irreplaceable resources. No artificially selected genetic strain has, to my knowledge, ever outcompeted wild variants of the same species in the natural environment." (Wilson, p.65).

The problem of rapidly dwindling species diversity is such that urgent steps should be taken to halt the process or at least to slow it down where possible. From an economic point of view, the genepool is the ultimate public good. It requires a lot of controls to ensure its preservation and increase. It means that market mechanisms must be overridden.

The Effects of Biotechnology

The systematic application of biotechnology to the artificial improvement of plants so as to increase yields, for example by means of inserting special genes designed to make the plant resistant to special diseases or herbicides runs the danger of making the genepool more uniform. Such a reduction in genetic diversity reduces plant variety and thus may present dangers to the security of the world's food supply. The disasters which struck the corn crops in the USA and the citrus harvest in Florida during the 1970s served to drive this point home. The suggestion that this uniformity might be offset by the use of a variety of manufactured genes might alleviate the danger but would not be a correction in principle.

This is not to suggest that biotechnology should be abandoned because of such dangers. What it does suggest is that the application of biotechnology should be made subject to very careful examination from the point of view of possible adverse effects on biodiversity. In this respect, the situation with regard to transgenic animals is somewhat easier, because there is a possibility of control over any harmful progeny. One possible approach could be a requirement that where genetic engineering is used and increases genetic erosion, a compensation should be developed. This is not a particularly easy solution, however.

The instrument of patent law is not suitable for the type of scrutiny envisaged. Under current legal rules, especially those applying in the USA, a patent could be granted for a plant enriched with manufactured uniform genetic material as long as it is new, useful and not obvious to somebody trained in the art. Such a patent would then enable the modified seeds to be sown on a very large scale. The problems of the corn and citrus crops might be repeated. Moreover, by systematically favouring particular forms of life, other plants might be threatened. Thus, by reducing genetic diversity, very unstable processes could be triggered. Should disasters strike, then the temptation would be to engineer different type of organisms, with another increase in instability and another increase in genetic erosion (Schuurman, 1987, p.13,14). Patents could pose, therefore, a threat to biodiversity.

Plant Variety Legislation

In 1973 the New Zealand Plant Variety Selectors Right Act was passed. Thus, New Zealand joined many other countries with that type of legislation. This legislation provides the breeder with a right which is very similar to copyright. As such it provides a possibility for greater diversity. I agree in this respect with Bezar, Smith and Whitmore who state that the collections of breeders contain considerable resources "developed through years of patient research and observation" and that:

"It is the responsibility of all breeders, whether they be private or government funded, to improve plant collections of wild material. Third world support groups might also be able to assist in the collection and preservation of this material and the prevention of overgrazing and damage which is a major problem in these areas" (Bezar et. al. p.7).

Plant breeding aimed at increasing diversity and variability is an art. By using newly discovered wild specimens this variability may indeed be enhanced. For the sake of preserving and developing food supplies every effort should be made to retain wild plant varieties. Genetically engineered plants should be used with great care and circumspection to prevent a potentially disastrous increase in genetic uniformity.

I suggest that the registration procedures carried out by a specialist agency to administer plant variety rights should be complemented by a supervisory body charged specifically with the task of supervising trends in biodiversity and with recommending guidelines for wise practice in this regard. This supervisory task should extend also to genetically modified plants and animals. Recommendations for wise practice should be developed in consultation with all breeders and organisations involved in land use. The Government should have the ability, if necessary in the public interest, to make certain recommendations binding.

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EVALUATION OF CHANGES IN WATER AVAILABILITY FOR CANTERBURY IRRIGATORS

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SUMMARY

This paper describes a methodology developed for the evaluation of the economic impacts of a reduction in water availability for irrigation. The evaluations described were commissioned by the Canterbury Regional Council as part of its obligations under the Resource Management Act (1991). The approach used involved the derivation of a method of describing water allocation rules to farmers in a manner which allows them to envisage the management implications of those rules. A postal survey was used to elicit details of land use from a large sample of farmers. The results of this were overlaid with data obtained from in-depth personal interviews with smaller samples of farmers in order to estimate changes in farm production, profitability and viability as a result of changes in water availability. The methodology derived is discussed in detail, the results of the studies summarized and some strengths of the approach identified.

INTRODUCTION

The Resource Management Act (1991) imposes on Territorial Authorities the responsibility for developing regional resource management policies and plans. In doing so they are required by the Act to consider alternatives and to assess the benefits and costs of implementation.

During the past two years the Canterbury Regional Council has been responsible for revising the river management plans for both the Ashburton and the Opihi River catchments. Existing management plans for these river catchments expired in 1990 but their provisions have continued since that time, during the process of community consultation and plan formulation. A draft plan for the Ashburton River has recently been released but is still the subject of debate between abstractive and in-stream river users. Formulation of the Opihi River Management Plan is not as far advanced.

In formulating these plans the Canterbury Regional Council has taken seriously its obligations under Section 32 of the Act to consult with the community and evaluate thoroughly the costs and benefits of alternative strategies. A number of studies have been commissioned on these rivers including hydrological investigations, and studies on the impacts of changes on fish, wildlife and recreational users of the rivers. Amongst these have been the studies on the economic impacts of changing the water available for irrigation from the rivers, which are the subject of this paper.

In commissioning these studies the Regional Council particularly desired to incorporate farmer responses to changes in water allocation. They were not, therefore, seeking analyses based primarily on models of agronomic production but wished to use survey methods to obtain information with which to estimate changes in individual farm and community economies.

The funding available precluded undertaking detailed personal interviews with the large numbers of farmers required to provide a high level of statistical validity. Rather, it was necessary to define a methodology which would provide the best estimates possible within the funding constraints imposed.

This paper describes the methodology defined and its application to the evaluation of changes in water availability from the Ashburton and Opihi rivers for irrigation. Water restrictions on the Ashburton affect private irrigators and those in the Greenstreet Irrigation Scheme most severely. Also affected are the farmers who irrigate from the Rangitata Diversion Race which takes 10 percent of its water from the Ashburton. The study commissioned on the Opihi River was to investigate impacts of water restrictions on irrigators in the Levels Plains Irrigation Scheme.

The Ashburton and Opihi rivers differ in the extent to which the changes proposed affect the availability of water for irrigation; in the types of properties using river water for irrigation; in the manner in which farmers have responded to existing levels of irrigation restriction and a number of other parameters.

METHODOLOGY

Survey Methodologies

In both studies two separate surveys were conducted. Firstly, postal surveys were undertaken to establish existing land use on the areas affected by the proposed water allocation changes. In the Ashburton area, questionnaires were sent to all farmers irrigating directly from the river and to a sample of 150 farmers irrigating from the Rangitata Diversion Race (RDR). The RDR, which supplies three irrigation schemes, takes only 10 percent of its water from the Ashburton River so the effects on these farmers, of restrictions on the Ashburton, were not expected to be great.

As fewer properties would be affected by the proposed restrictions on the Opihi, all 76 of the shareholders in the Levels Plains Scheme, whose addresses were known, were surveyed.

Response rates of 79 and 76 percent respectively were obtained on the Ashburton and Opihi surveys.

Random samples of farmers were then selected for in-depth personal interviews intended to elicit details of the changes in farm production and practices expected as a consequence of changes in water availability. These interviews were carried out by an experienced farm consultant. His role included ensuring that respondents were able to understand the issues with which they were presented and that the answers given were consistent. It may be

argued that farmers had an incentive to inflate the effects of reduced water availability. However, the interview structure was designed to minimize their ability to do so and to show up any inconsistencies which did arise.

In the Ashburton study thirty personal interviews were conducted. Fifteen of these were conducted amongst the fifty three farmers who irrigate privately from the river or who belong to the Greenstreet Irrigation Scheme. These properties are entirely dependent on the Ashburton for irrigation water. The remaining interviews were conducted amongst the 349 RDR farmers.

The area irrigated by the Levels Plains Irrigation Scheme is characterised by a large number of small-holdings and lifestyle blocks with only a small number of commercial properties. Amongst respondents to the postal survey, 26 percent farmed commercially and their properties comprised 72 percent of the survey area. Even amongst properties described by their owners as commercial, farm sizes are, in the majority of cases, small.

Detailed personal interviews were conducted only with commercial farmers although the consultant visited a number of small-holders to discuss the implications of the proposed changes.

Presentation of the Allocation Rules to Farmers

The allocation rules for evaluation were described by the Regional Council in terms of a minimum low flow at specified measuring sites and of sharing rules between instream and abstractive users at levels above that.

In the case of the Ashburton, data was available for the Regional Council to model the restrictions which would have applied under each allocation rule during each month of the preceding nine years. For the Opihi study the exercise could be conducted for the preceding twenty five years. For purposes of the analysis the irrigation period was divided into two - September to December and January to April. Figure 1 shows the restrictions modelled for the Levels Plains Scheme under the existing management plan. Restrictions are imposed at four different levels according to river flows.

Clearly this picture was too complicated to demonstrate the implications of restrictions to farmers. Several steps were taken to simplify it. Firstly, the irrigation restrictions predicted for each year were converted into "full restriction equivalent days" (FRE days). Conversion to FRE days involved multiplication of the number of days of each level of restriction by the percentage reduction imposed by that restriction. Thus while a day when no water was available for irrigation was one FRE day, a day when 1.98 m³/sec of the 3.06 m³/sec maximum specified by water rights was available was equivalent to .631 FRE days. It was considered that from a management perspective, there was little practical difference to the farmer between these two situations.

In order to derive the scenarios which best represent the restrictions which would have arisen under these allocation rules, the years in which a similar number of FRE days would have occurred were grouped. It was assumed that farmers would be unlikely to be able to assess their responses to small changes in the number of days of water restriction. A number

of scenarios, described by the average number of days of restriction in each half of the irrigation season, were derived. The same scenarios were used to describe each allocation rule, with only the probabilities of each scenario's occurrence varying.

The five scenarios derived for the Levels Plains farmers are shown in Figure 2.

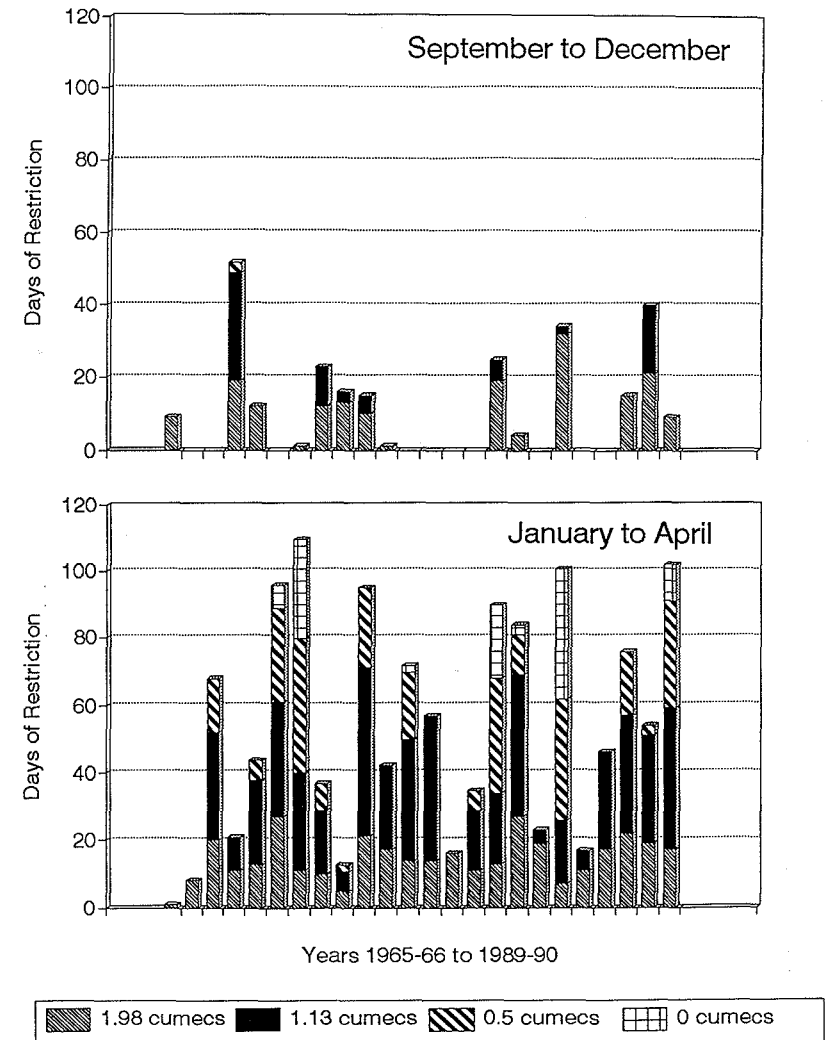


Figure 1
Days of Irrigation Restriction Under the 1984 Opihi River Management Plan

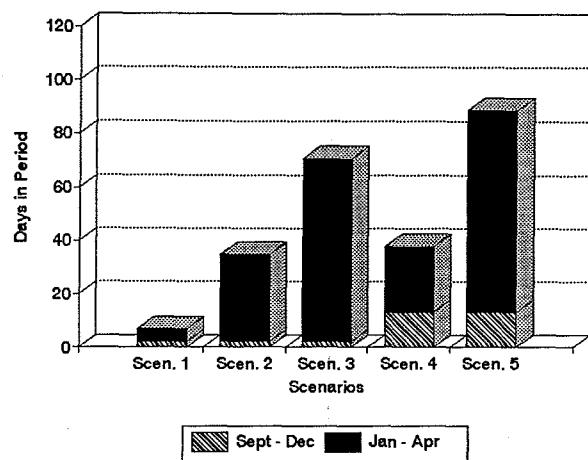


Figure 2

Water Restriction Scenarios for Levels Plains Irrigators

The final stage in interpreting the proposed allocation rules for the farmers interviewed was the derivation of probabilities of each scenario's occurrence under each management rule.

In the case of the Levels Plains study, this was relatively straightforward as probabilities were derived directly from the frequency with which each scenario would have occurred, under each allocation rule, during the previous 25 years.

The modelled restrictions for the Ashburton were available only for the years between 1982/83 and 1990/91 since the model uses data from two flow recorders in use only since 1982. Nine year's data is insufficient to reflect the probabilities of particular levels of river flow, and therefore of irrigation restriction. Consequently, it was decided to use a more subjective method of estimating probabilities using the nine years for which data were available as a reference period.

River flows on the South branch of the river had been recorded since 1967. Examination of rainfall data in the area suggested that this period encompassed a more typical range of rainfall than the shorter period for which flow data were available. Regression analysis undertaken by Regional Council staff showed reasonable correlation between rainfall at sites in the catchment and run-off near the South Ashburton hydrological site. It was therefore assumed that river flows during the period would also have encompassed the typical range.

As the South Ashburton catchment is considerably larger than the northern catchment it was decided to use the South Ashburton flow rates to allocate restriction scenarios to the years between 1967 and 1982. Monthly summaries of this data were sorted in ascending order of flows so that each month in each year could be related to the most similar month during the reference period. Daily flow data were also scanned in order to check the validity of this allocation.

Using the reference period monthly restrictions as a basis, the days of restriction for each month of the irrigation season were estimated for each year and summed to give days of restriction in each of the two periods of the irrigation season. Each year was then fitted to one of the defined scenarios and the probabilities of occurrence of each scenario calculated. These probabilities were depicted in pie chart form for use in describing the allocation rules to farmers. Figure 3 shows the probabilities of the occurrence of each scenario under the 1984 Opihi River Management Plan.

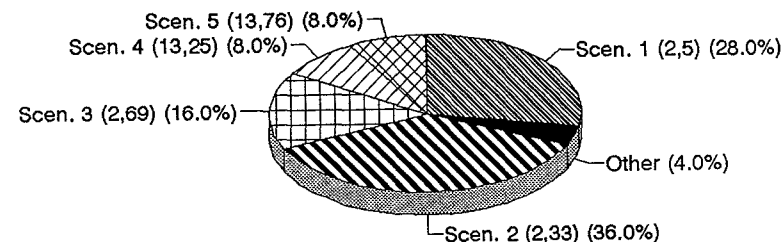


Figure 3

Probabilities of Occurrence of Each Scenario Under the 1984 Opihi River Management Plan

The irrigation restrictions imposed by each of the four proposed management plans for the Ashburton River differed markedly and it was felt that farmers would have no difficulty in distinguishing between the impacts of each.

In the case of the Opihi, however, the differences were very much less significant and it was felt that there would be little if any structural change between the existing plan and the least restrictive alternative. Consequently it was decided not to investigate responses to this plan during the personal interviews but to analyze its impacts by changing the restriction probabilities only. Figures 4 and 5 show the relationships between allocation rules and scenarios for both the Ashburton and Levels Plains irrigators.

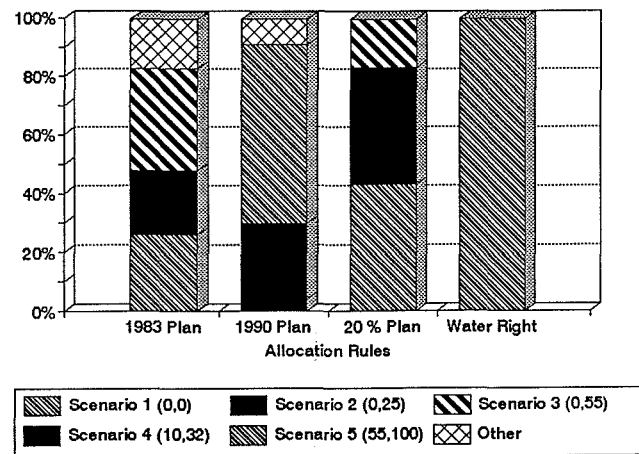


Figure 4
Relationship Between Allocation Rules and Scenarios - Ashburton River

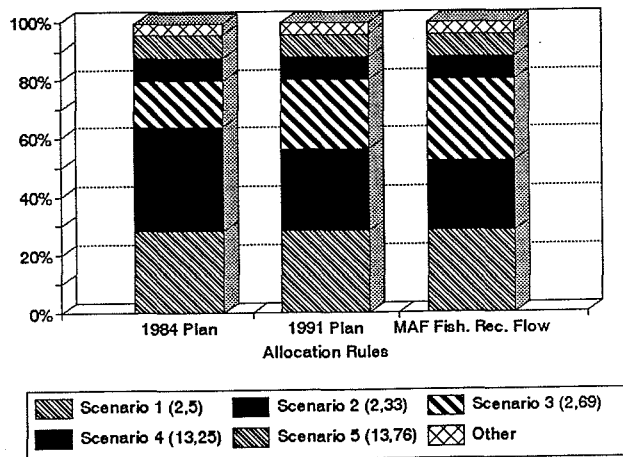


Figure 5
Relationship Between Allocation Rules and Scenarios - Opihi River

Farmer respondents were asked firstly about their farming practices, production and profitability under the current water allocation plan. Using the diagrammatic representations of the water restriction scenarios, as a means of explanation, short-term responses to the imposition of water restrictions were discussed. Data required to complete budgets for each scenario were obtained, including all production and cost implications.

The diagrams showing the probabilities of differing levels of water restrictions under each of the hypothetical water allocation plans were used to illustrate those plans to respondents. They were then asked to describe the long-term structural changes they would expect to make if faced with the imposition of each of those plans. Finally they were asked about their short-term responses to restriction scenarios occurring within the new long-term structures.

After the interviews a series of budgets was prepared for each property for use in the subsequent analysis. For each property a budget was produced for each scenario under each water allocation rule.

Extrapolation from Survey Data to Scheme as a Whole

The approaches taken to estimating total land use from the data obtained in the postal surveys differed according to whether information was available on the contract irrigation area. In the case of the direct irrigators from the Ashburton, there was no information on total area irrigated privately and the total area was calculated by dividing survey areas by the proportion of those surveyed who responded. For the area covered by the RDR and Levels Plains scheme totals were estimated by dividing survey totals by the proportion of contract area farmed by respondents.

In order to estimate the results of changes in water availability, the total stock units, crop areas and yield of all farm products as well as farm costs were calculated under each scenario for each of the allocation rules. Totals for each scenario were weighted by the probability of that scenario's occurrence under a particular allocation rule, in order to estimate land use and total farm production and profitability under that rule. Average percentage changes in these parameters between allocation rules were then calculated.

For the Ashburton, changes in land use and farm production and cost parameters for the scheme as a whole were estimated by applying the percentage changes between allocation plans, recorded over all survey farms, to the estimated total stock units and crop areas under the existing plan. It was considered, that given the variability in land use patterns in the area, this would provide more accurate estimates of total changes in production than simply aggregating upward from the percentage of farmers personally interviewed.

This approach was used in the Levels Plains study to estimate changes on the total area farmed commercially. On the basis of discussions held with small-holders, it was considered that relatively few structural changes would be made by small-holders in response to changes in water availability. The only expected change was a small reduction in sheep numbers if a more restrictive plan were to be introduced. Consequently, the expected percentage change in sheep stock units on commercial farms was applied to small holdings. It is possible that there will be an increase in small-scale horticulture carried out on these blocks but this is unlikely to constitute a major change in land use.

In the case of crop areas, the change in total crop area was calculated and percentage movements between crops within that total area applied to postal survey data.

Calculation of the total value of agricultural production under each allocation rule involved accounting for changes in both units of production and per unit productivity. This involved two stages. The first involved calculation of the total numbers of productive units as described. In the second step, the total number of productive units were multiplied by the mean per unit value of production, calculated from survey farm data for the particular allocation plan. Values were calculated at both average prices prevailing in that season and, in the Ashburton study, at the prices forecast for the following season by the Ministry of Agriculture and Fisheries (MAF, 1992).

Regional implications were examined using regional multipliers based on the 1986/87 input-output tables, although a number of issues, including the many structural changes in the agricultural sector since those tables were derived, mean that these estimates are very coarse.

Changes in individual farm profitability on the farms surveyed were investigated and the issue of farm viability was also examined as far as possible using rules of thumb such as debt servicing as a percentage of gross farm income, and the surplus available for drawings, taxation and investment. Detailed investigation of issues affecting viability was not possible within the constraints of this study.

RESULTS

The results of the two studies were markedly different. Changes to the water allocation plan for the Ashburton River may have significant effects on the income and viability of individual Greenstreet and private irrigators, on the level of farm output from the area using irrigation water from the river and on the level of regional income. The study showed that if the plan which had originally been signposted for implementation in 1990 were adopted, mean farm productivity for private and Greenstreet irrigators would decline by 30 percent. This would lead to a reduction in profitability of 69 percent. Under this regime, the viability of at least 50 percent of those farms would be threatened. Impacts on individual RDR farms were not estimated to be large but in aggregate outweighed the total production loss from the smaller group of more severely affected properties. The value of lost production at the farmgate from the whole area was estimated to be \$6.2 million per year.

If the river flows were to be enhanced, the productivity of the farms irrigated privately or from the Greenstreet Scheme would be increased by 13 percent and net farm profitability by 72 percent. However, the smaller impact on the RDR farmers would result in an increase in the total value of production at the farmgate of only \$2.2 million per annum.

The proposed reductions in water availability to the Levels Plains Scheme would have relatively small impacts overall. This reflects, to some extent, the number of small-holdings. More important was the extent to which farmers in this area already farm below the land's potential in order to minimize losses during dry years. For the relatively small number of intensively farmed properties, wholly or primarily reliant on Scheme water, the implementation of this proposal would require significant structural changes in their farming

operations to less intensive, less profitable systems.

However, if the Opihi were to be augmented so that irrigators were assured of the quantity of water specified in water rights there would be a significant increase in the value of output. On the basis of information obtained in this study an increase in the gross value of output of 12 percent may be expected. This must be regarded as a 'bottom-line' estimate since it is probable that once farmers have adjusted to a secure water supply they would intensify production to a greater extent than they are able to envisage from their present perspective.

DISCUSSION

The method of assessing the impacts of changes in water availability for irrigation described in this paper was developed to address a problem not previously tackled, and for which limited resources were available. It has been applied in two situations which differed markedly and in each three strengths of the approach were apparent.

Firstly, the approach taken has farmer validity. Farmers were able to understand and respond to the framework used. The responses given by the individual farmer to each water allocation plan appeared to be consistent with his responses to other plans. The structure of the interview would have made this difficult to contrive. The consultant who conducted the interviews also felt that the responses given were consistent with his perception of respondents' individual characteristics such as attitude to risk, managerial acuity, etc.

The exception to the pattern of consistent responses was the responses to one of the allocation plans evaluated for the Ashburton River which proposed a twenty percent reduction across all water rights at all times. Farmers could see no validity in such a plan (which had not previously been mooted) which they did not see as meeting any of the stated objectives of the management plan. Because farmers did not see this plan as credible, their responses to it were not consistent.

Secondly, the diversity of responses obtained from farmers in similar situations showed that an approach which ignored the many influences on the way individuals react to change is unlikely to reflect the true impact of those changes. An approach such as this, using expert opinion to interpret farmer response, although lacking statistical validity, is able to incorporate those influences.

Finally, this approach permits identification of groups of individuals who will be most severely affected by changes in resource availability and of the extent to which they will be affected, thus assisting communities to consider issues of equity in developing resource management plans.

Clearly, it would be desirable to conduct these studies with sufficient resources to achieve higher levels of statistical accuracy. Equally clearly, Regional Council funding will continue to be severely constrained. However, particularly where the potential influence of resource management changes is likely to be great, the importance of the results to the affected communities warrants devoting resources to obtaining the best information possible.

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ELECTRICITY INDUSTRY REFORMS: IMPACTS ON THE AGRICULTURAL SECTOR AND THE RURAL COMMUNITIES¹

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INTRODUCTION

The key objective of electricity industry reforms is to improve the *long term efficiency* of the industry by removing barriers to competition. This is consistent with Government's energy policy objective of ensuring continuing availability of energy services at the lowest cost to the economy. It is anticipated that improved efficiency and competitive pressures will result in more *prudent capital investment* in the electricity industry.

The energy sector, of which electricity is a vital component, is the last major sector of the economy to be reformed. Network industries such as airlines, telecommunications, transportation (rail and trucking), ports and the oil market have been deregulated in the recent past. In some cases, deregulation has been followed by corporatisation and privatisation (eg Telecom).

Overall, these reforms have led to significant *benefits to the economy*. The magnitude of these benefits have, however, varied between sectors. Some groups have been *disadvantaged* by reforms in other sectors. Concern has been expressed that deregulation of service industries will particularly disadvantage those in *rural areas*, who will face higher costs and potential loss of services altogether. However, in several cases these fears have proved to be unfounded, or at least overstated.

Electricity is extremely important to the *export sector* and other productive sectors of the economy as well as the household sector. In *agriculture*, electricity accounts for up to 8% of the total operating expenditure for dairy farms, 3-4% for sheep and beef farms and about 1-2% for kiwifruit and pipfruit operations. There is also considerable use of electricity by the sectors *processing agricultural products* for the export markets. More importantly, many production processes on-farm (eg, milking, shearing) and off-farm (eg, milk processing, meat works) are critically dependent on electricity as the main or only source of energy.

OBJECTIVES OF THE PAPER

This paper intends to provide an *overview of the reforms* underway in the different component activities of the electricity sector. It will then identify the *implications* of these reforms for the agricultural sector and rural communities.

MAF's interest in the electricity sector reforms focuses on the impact of the reforms on the agricultural sector and rural communities. *MAF Policy* has participated on the inter-departmental officials committee formed in 1990 following the Government Task Force Report of 1989.

Work in the area has also been undertaken by the *Rural Resources Unit* within MAF Policy, which is charged with ensuring "adequate access to information and basic services for rural communities" (MAF 1993a:6).

Therefore, the *key objectives* of this paper are as follows:

- to provide an overview of the New Zealand *electricity sector*;
- to *outline the reform* process, decisions and actions taken;
- to discuss the importance of electricity for the *agricultural sector*;
- to identify potential problems and opportunities for *rural communities* as a result of the reforms; and
- summarise the *measures in place* to alleviate the concerns of rural households.

STRUCTURE OF THE NEW ZEALAND ELECTRICITY SECTOR

The electricity sector in New Zealand is over 100 years old. The turnover of the electricity industry is about \$3.5 billion per annum, which represents between 2% and 3% of Gross Domestic Product. This percentage, however, understates the critical nature of electricity in the economy and its vital importance to almost all industries. Inefficiencies in electricity supply, therefore, have an important effect on the standard of living in New Zealand and on the international competitiveness of our export industries (Culy, 1992).

The current *cost distribution* of the electricity industry among its four main activities in the supply of electricity to consumers is as follows:

Generation	50%
Bulk transmission (the national grid)	20%
Local distribution	27%
Local retailing or trading	3%

The bulk transmission and local distribution activities are usually known as "lines" activities. These are effectively "natural monopoly" activities, whereas generation and retailing are potentially competitive.

¹ Views expressed in this paper are those of the authors and do not necessarily reflect the official view of the Ministry of Agriculture and Fisheries. The helpful suggestions and comments of colleagues at MAF Agriculture Policy are acknowledged. Errors and omissions remain the responsibility of the authors.

Electricity Generation

The generation of electricity is mostly carried out by the *Electricity Corporation of New Zealand* (ECNZ), previously known as Electricorp. This is a State Owned Enterprise (SOE) established in 1987 as the first step towards privatising the energy sector in New Zealand. The primary electricity generation activities and their share of total generation in 1992 consisted of hydro (65%) and geo-thermal (7%), while the secondary generation processes such as from coal (3%), oil (<1%) and gas (24%) accounted for the rest (Energy Data File, 1994).

Electricity Transmission

Electricity generated is transmitted across the country from the major points of generation to the main centres of consumption through high voltage lines known as the national grid. This transmission is carried out by *Trans Power*, a subsidiary of ECNZ (until 30 June 1994).

Electricity Distribution

Local distribution of power to consumers over a network of lower voltage lines historically was the responsibility of Local Power Boards and Municipal Electricity Departments (MEDs). Collectively known as *Electricity Supply Authorities* (ESAs), these bodies were established as power companies on 1 July 1993.

There were 44 *energy companies* operating in January 1994, down from more than 50 ESAs before the reforms in April 1993. This reduction is the result of amalgamation of some adjacent ESAs, which is part of a rationalisation process expected to continue for some time. Some analysts believe that there could ultimately be fewer than 10 large power companies in New Zealand.

Electricity Demand

Electricity accounted for about 15% of total *consumer demand for energy* in 1992, the rest being met by liquid fuel (32%), gas (39%) and to a lesser extent solid fuel sources such as coal (9%) and wood (5%) (Ministry of Commerce, 1994). Electricity is, however, the main source of energy for households, with a market share of around 85%. The major competing energy source in the household sector is natural gas, currently available to about half of New Zealand households.

The *demand for electricity* grew at around 7-8% per annum during the 1960s and the early part of 1970s. It grew steadily at about 3% per annum during the 1980s, despite very low economic growth (1-2%) and low population growth (0.5%). This 3% growth was made up of a modest increase of about 1.5% per annum in household use and a stronger demand in the commercial and manufacturing sectors of around 4% per annum.

The differential between the growth in *electricity demand and economic growth*, which was around 4% 20-30 years ago, has continued to fall and is under 1% per annum at present. This reflects a maturing market for electricity and also the saturation of household electricity use, stronger competition from gas and greater efficiency of electricity use (Culy, 1992).

PAST ROLE OF RURAL ELECTRICAL RETICULATION COUNCIL (RERC)

Despite the success of power boards in *general electrical reticulation*, the remaining 3% of the population without electricity supply in 1945 represented a sizeable group in terms of the rural productive capacity (RERC, 1991). The potential technological and lifestyle improvement opportunities offered by electricity in rural areas was expected to further boost rural production and foreign exchange earnings.

As a result, RERC was *established* in 1945 to help meet the cost of attaching rural dwellers to the national grid. The government of the day saw it as important for rural areas to be supplied with electricity, while supply authorities wanted to ensure increased usage and a more viable electricity system.

While electricity's impact on farming was significant, as an energy source it remained overshadowed by the internal combustion engine. Of greater consequence was the *social impact* of rural electrification and the way it improved the daily existence of farmers and their families.

Operation of RERC

RERC's operation developed in distinct phases. Until about 1965, RERC dealt with requests for relatively small amounts of subsidy from virtually all the power boards as they filled in the many gaps in their own areas which had been marginally uneconomic. After 1965, the areas remaining without electricity tended to be those which were extremely remote from the national grid such as the East Coast region of the North Island, the Marlborough Sounds, South Westland and offshore islands (eg, Stewart Island). RERC tended to supply much larger subsidies to these fewer areas.

Standalone Systems

The original 1945 legislation permitted RERC to fund new line extensions to existing reticulation only. As some areas could not realistically be supplied from the national grid with the prevailing technology, the legislation was amended in 1968 to allow RERC to fund *standalone systems and community schemes*.

During the next 20 years, however, the frequency of standalone *subsidy approvals* seldom exceeded 10 units per annum. But with little progress made on community schemes, a significant leap in approvals was recorded starting from 1988, when more than 150 applications for standalone subsidies were approved over three years.

This *upsurge* was attributed to factors such as greater public awareness of RERC, policy revisions enabling hybrid systems, marketing strategies of alternative energy equipment suppliers capitalising on RERC's subsidy policies, changes in the subsidy payment system from annual instalments to a one-off commuted lump-sum method and the likelihood of subsidies disappearing with the possible termination of RERC.

RERC's concern over this upsurge was mainly related to its *fiscal ability* to meet its obligations. A more fundamental concern was over the achievement of its objectives, as some line extensions sought were of no benefit to the nation. RERC was wary of "rural lifestyle" taking advantage of RERC's mandate. Reticulation was capitalised into land values after purchasing remote rural land lacking amenities at a discount.

The need to minimise unwarranted standalone subsidy payouts resulted in a tightening of the *eligibility criteria* in 1990. This included permanent residency in the area for 5 years and full-time employment in or servicing the primary industry in that area. The applications for subsidies were received up to 31 March 1993, for new connections only and not for maintenance or replacement.

Funding of RERC

RERC was funded by a *levy* of up to 0.5% of the sales revenue of all Electrical Supply Authorities. But in recent years, with the virtual completion of reticulation throughout the country, the Council's budget has been held constant at nominal \$2 million per year and the levy required was 0.1% of sales revenue.

Since its inception, some 17,000 kilometres of line have been constructed with RERC assistance to serve about 17,000 original consumers. An estimated 55,000 consumers are now supplied by these lines (Ministry of Commerce, 1990).

NEW ZEALAND ELECTRICITY INDUSTRY REFORMS

Almost a decade ago, New Zealand began considering a series of significant changes to the electricity industry aimed at introducing commercial pressures and opening the way for competition. This was part of a major programme of *state-owned-enterprise reform* undertaken by the 1984 Labour Government intended to improve the efficiency of state owned trading activities.

Wider reforms of the industry was first studied by a *Government Task Force* which reported back in 1989. Its main recommendations related to the separation of transmission and generation, competition in generation and commercialisation of the power companies with the removal of franchise monopolies and the separation of line and energy charges.

While these recommendations were accepted in principle, further work was required to examine these issues in detail. An *inter-departmental officials co-ordinating committee* made up of about 8 departments and agencies including MAF was formed in 1990. This was followed by the commissioning of a number of official and industry-sponsored studies. The officials reported back to the Cabinet State Sector and Cabinet Strategy Committees on various issues studied.

In 1992, following the major decisions on distribution sector reforms, the larger officials committee was reduced in size to represent only the Ministry of Commerce, Treasury and the Ministry for the Environment. This was called the *Officials Committee on Energy Policy* (OCEP). OCEP was charged with developing the Government's overall *Energy Policy Framework* and the *Energy Advisory Work Programme*, in consultation with all other departments previously represented in the full committee.

Generation Sector reforms

Reforms of the New Zealand electricity sector in effect commenced in 1987 with the formation of *Electricorp* (now ECNZ) as an SOE from the New Zealand Electricity Division (NZED) of the Ministry of Energy. Once corporatised, ECNZ established *Trans Power* as a subsidiary company to own and operate the national transmission grid. In the

same year, the monopoly on generation was removed and ECNZ, which currently has about 95% of the total generation capacity, was freed from any obligations to provide new capacity.

Generation restructuring is a complex issue which has been examined a number of times in the past. Reforms in the future could involve the *break-up of ECNZ* into 3 or 4 components along the lines of current hydro storage on river systems in the North and South Islands and the geo-thermal system in the North Island. The key objective is to reduce *potential entry barriers* to alternative and/or renewable generation ventures (ie. Independent Power Producers). In order to create competition in the generation sector, ECNZ's current 95% capacity is expected to be reduced to between 60-70%. This has to be carried out without significant loss of dynamic (eg, investment), productive (eg, managerial) and allocative (eg, pricing and quality) efficiency.

Transmission Sector reforms

The *Trans Power Establishment Board (TPEB)* was set up by the Government in 1990 with the task of making recommendations for legally separating Trans Power from ECNZ. It reported back in 1991, setting out proposals for a suitable structure, ownership and regulation for the grid including its valuation and pricing. It also recommended in principle the establishment of a wholesale electricity market. Trans Power has operated as a subsidiary of ECNZ since 1992. After considering several ownership structures for Trans Power, government recently decided to make it an SOE from 1 July 1994.

The *Wholesale Electricity Market Study (WEMS)* was established by the electricity industry participants in December 1991. Its broad objective was to establish a genuine wholesale market for electricity and to remove barriers to entry to the generation market. Its main recommendations were an independent wholesale market achieved by externalising and modifying structures operated and controlled by ECNZ.

The Government subsequently undertook a review of the WEMS proposals (the Troughton Critique) and concluded that it neither accepted or rejected the WEMS recommendations. It wished to see further work in consultation with other non-industry parties to develop more detailed proposals.

To this end, the *Wholesale Electricity Market Development Group (WEMDG)* was formed in mid-1993 to make specific cost-effective proposals for a wholesale market consistent with sustainable development. A draft proposal for the "Wholesale Electricity Market" to be evaluated was released by WEMDG in March 1994. This report contained a "Market Proposal" and a "Benchmark Proposal", the latter being a slight modification to status quo.

The report covered a range of issues including long-term vesting contracts for bulk electricity purchases, rules of operation for the power pool company, the market surveillance panel and the interaction of the pool company with Trans Power. The *Electricity Market Company (EMCO)* set up by ECNZ and the Electricity Supply Association of New Zealand (ESANZ) in 1993 is likely to be this pool company.

This proposal was then studied by various industry and consumer groups and other stakeholders in the reforms during April. A risk evaluation exercise involving all the participants was carried out by WEMDG during May in order to identify potential areas

of concern and likely system failure. Final recommendations to the Government on the proposed wholesale market is expected in July 1994.

Distribution and Retail Sector reforms

Since the report of the Electricity Task Force of 1989, the distribution and retail sectors of the New Zealand electricity industry have undergone radical reform through deregulation and corporatisation.

The Labour Government announced its intention to corporatise ESAs just prior to the election in 1990. Several studies were undertaken at this time in relation to the proposed distribution sector reforms. These included: "Potential impacts on retail electricity tariffs from commercialisation and regulatory changes" (Ernst & Young, 1990), "Social and Rural Impacts of electricity distribution industry reform" (Ministry of Commerce, 1990) and "Future role and functions of the RERC" (RERC, 1991).

The *Electricity Distribution Reform Unit (EDRU)* was formed by the Government in 1991 to work in association with the RERC. The purpose was to facilitate the distribution sector reforms recommended by the Government Task Force Report.

The *Energy Sector Reform Bill* which was presented to the Cabinet Legislation Committee in late 1991 was passed by the Parliament in 1992. It became effective as The Energy Companies Act and The Electricity Act.

Corporatisation of Power Boards

The *Energy Companies Act* of 1992, which came into effect on 1 April 1993, required all electricity supply authorities (ESAs) to become companies. This was achieved by replacing their local government structures with normal corporate structures.

Interim Trusts set up to establish the companies grappled with trying to find structures in each area that allowed the new companies to operate successfully in the new competitive environment, while meeting consumer and community interests. A range of ownership and management structures have resulted for the new corporate ESAs, including long-term Trusts, local council ownership and consumer ownership through partial share giveaways.

In most areas, this process generated considerable heat and discussion. The proposed *establishment plans* of each company had to be approved by the Minister of Energy before implementation. The new power companies also had to account separately for their lines and energy businesses so that a clear demarcation will be made between the monopoly elements (lines) and the competitive elements (energy) of power reticulation.

Removal of Franchise Areas

The *Electricity Act of 1992* required the progressive removal of territorial franchise areas. This was implemented first for customers using less than 0.5 GWh per year on 1 April 1993 and then for all customers from 1 April 1994. This Act also required the introduction of comprehensive information disclosure regimes. The aim was to empower customers and others to challenge any apparent inefficiencies or inequalities.

Separation of Charges

The Act also required the separation of *network or line charges* from the charges for the actual *electrical energy* used. This requirement was to facilitate competition in energy trading and also support information disclosure for network operators.

At the same time as this separation was being introduced, many supply authorities (subsequently energy companies) *increased fixed charges* for both energy and network use. Fixed charges are those charges included in electricity accounts that do not vary with normal changes in the quantity of electricity consumed.

Line use and energy consumption charges were combined into a *single tariff in the past*. These charges were totally variable in the case of many ESAs, while some ESAs made a relatively small fixed charge. Fixed charges however, are not line or network charges. Line charges of most power companies presently have both a fixed part and a variable part related to actual energy use.

There are complex arguments for and against the use of *higher levels of fixed charges*. Typical arguments favouring higher fixed charges focus on the need to ensure that costs that are fixed are reflected in fixed charges so that customers make decisions reflecting the real cost of the resources used. The arguments against higher fixed charges include the incentives for more electricity consumption or conversely disincentives for saving and energy efficiency as well as higher total electricity cost for small consumers on low incomes.

Company Mergers

With the complete removal of territorial franchise areas, the separation of network charges from energy charges and the information disclosure regimes, power companies were likely to *gain and lose customers* through competition. The larger consumers of electricity, such as factories, with sufficient economies of size to shop around were most likely to change their electricity suppliers. Four establishment plans submitted by ESAs thus involved *mergers* between adjacent supply authorities (eg, Cambridge and Te Awamutu, Waitemata and Thames Valley, New Plymouth and Taranaki, South Canterbury and Timaru) to make them more viable. Some organisations with multiple locations now have scope to pursue single energy supply deals. For example, four companies are joining together to offer a bulk electricity deal to all schools. This could offer significant savings, particularly to remote rural schools.

Tariff rebalancing

Another expected outcome of the government's reform of the electricity distribution industry is the *removal of cross-subsidisation* between consumer groups. Traditionally, ESAs in New Zealand have significantly overcharged small and medium sized commercial electricity users and undercharged domestic and rural users.

The best available estimate of the *extent of the cross-subsidy* is for 1990 (Bodmer, 1991). This estimate takes account of the different costs and rates associated with different customer groups. The Index of Costs when compared with the Index of Rates suggest that the cost (129) and the rates (134) for farmers were not very dissimilar. But the Index of Cost (66) and the Index of Rates (113) for industrial users were quite different. This

quantifies the extent of cross-subsidisation of domestic or household consumers by the industrial users. Lower extra rates over cost for farmers can be partly attributable to their operation in the rural areas, which were cross subsidised by urban dwellers.

Some degree of cross-subsidy is a *normal commercial practice* because of the prohibitive financial and business costs of trying to precisely allocate costs to each customer. But cross subsidies of the magnitude that applied in the electricity industry in 1990 could not be justified under competitive conditions and were not likely to be sustained. The progressive removal of cross subsidies is usually described as *tariff rebalancing*. It has been progressing at different speeds in different ESA regions since the prospect of commercial reforms became imminent around 1989. Some ESAs had completed rebalancing prior to corporatisation in 1993 while others still had some distance to go.

Tariff Monitoring

The electricity tariff monitoring work established by the Electricity Distribution Reform Unit (EDRU) in 1991 has been continued by the Rural Electrical Reticulation Council (RERC) since 1993.

This monitoring work is based on the published retail electricity tariffs available to consumers from all electricity network companies that distribute electricity from the national transmission system (RERC, 1994).

Electricity tariffs being inherently complex, the monitoring does not focus on a direct comparison of tariff rates. It looks at the amount of money that a range of standard consumers would have to pay for a specific amount of electricity. The *domestic* and *farm consumers* are categorised into *small* (500 KWh per month), *medium* (1000 KWh-domestic and 1500 KWh-farm), and *large* (1500 KWh-domestic and 3500 KWh-farm) sizes according to their level of electricity use.

For each customer class, the total cost of electricity supply is calculated for a 30 day month. This is then divided by the number of units purchased to produce the *total cost per unit of electricity*. Fixed costs that are part of the total cost of electricity are reported as *total fixed cost per month* for information purposes. The unit costs, however, include the fixed costs incurred as well.

To provide the overall national trends, *weighted average prices* are computed using the total sales volume (KWh) for each supplier in the domestic and farming categories respectively. The sales figures are those reported in the "Annual Statistics in Relation to the Electric Power Industry in New Zealand" produced by the Ministry of Commerce.

In the following tables, the total electricity cost per KWh and the fixed cost per month are reported for *small domestic* (500 KWh per month) and *medium size farm* (1500 KWh per month) consumers. The tariffs reported were effective for the *most recent year* (late 1993), for the *preceding year* (late 1992) before distribution sector reforms came into effect and for an *earlier year* (1989 or 1990).

Table 1: Summary Measures of Total and Fixed Tariffs for Electricity Supply Authority Regions - Changes Over Time (Real 1993 prices)

Present Levels - December 1993				
	Small Domestic c/KWh	Medium Farm c/KWh	Fixed Costs (\$/month)	
			Domestic	Farm
Mean	10.88	11.55	16.02	21.58
Std Devn	1.37	2.03	6.89	14.02
Maximum	14.38	16.77	40.69	70.43
Minimum	8.39	8.68	0.00	0.00
Recent Levels - November 1992				
	Small Domestic c/KWh	Medium Farm c/KWh	Fixed Costs (\$/month)	
			Domestic	Farm
Mean	10.33	11.52	13.86	15.55
Std Devn	1.09	1.71	4.83	6.97
Maximum	13.01	15.46	27.97	35.22
Minimum	8.45	7.40	0.00	0.00
Past Levels - 1989 or 1990				
	Small Domestic c/KWh	Medium Farm c/KWh	Fixed Costs (\$/month)	
			Domestic	Farm
Mean	10.20	13.05	9.71	10.60
Std Devn	1.36	2.00	4.07	4.98
Maximum	13.22	17.95	18.77	27.31
Minimum	6.89	8.46	0.00	0.00

Table 1 reports the *summary measures* for all the 44 power company regions which were in operation in late 1993. Table 2 compares the average tariff results for power companies operating mainly in the *urban and suburban regions* with those serving largely *rural areas*. The same information for those power companies which have established *long term community trusts* is also provided. In some cases, these companies have implemented share give-away plans to their legitimate customers.

Table 2: Differences on Tariffs and Tariff Changes

IMPACTS OF REGIONAL AND POWER COMPANY OWNERSHIP DIFFERENCES ON TARIFFS AND TARIFF DIFFERENCES												
Present Levels - December 1993				Recent Levels - November 1992				Past Levels - 1989 or 1990				
	Small Domestic	Medium Farm	Fixed Costs Domestic	Farm	Small Domestic	Medium Farm	Fixed Costs Domestic	Farm	Small Domestic	Medium Farm	Fixed Costs Domestic	Farm
A. Community Trusts with Share Give-away Plans Implemented												
Mean	10.81	11.09	15.68	21.18	10.22	11.23	12.42	13.21	10.44	13.44	9.47	10.60
Std Devn	1.33	1.13	7.81	15.31	0.88	1.39	4.38	4.97	1.22	2.06	4.96	5.68
Maximum	12.98	12.46	33.00	54.66	11.58	12.98	19.79	20.02	12.96	17.95	18.77	18.77
Minimum	8.39	9.16	2.96	10.30	9.15	9.16	4.82	4.82	8.53	10.16	0.00	0.00
B. Urban and Suburban Areas												
Mean	10.89	12.22	16.69	26.01	10.20	11.70	12.41	16.22	10.20	13.58	8.75	9.98
Std Devn	1.63	2.51	10.47	22.48	1.00	1.49	4.92	9.60	1.52	1.98	5.33	5.73
Maximum	14.07	16.77	40.69	70.43	12.31	14.69	19.79	35.22	12.99	17.95	18.77	18.77
Minimum	8.39	8.68	0.00	0.00	8.74	8.76	0.00	0.00	8.10	10.29	0.00	0.00
C. Remote Rural Areas												
Mean	11.28	12.50	19.51	30.71	11.10	12.64	15.66	16.64	10.32	13.54	12.19	14.21
Std Devn	1.68	2.41	3.90	10.37	1.63	3.02	4.35	5.87	1.17	2.24	2.61	6.77
Maximum	13.89	15.92	24.00	46.76	13.01	15.46	19.86	25.73	12.41	17.23	15.17	27.31
Minimum	9.38	9.02	15.00	15.20	8.74	7.40	10.01	10.01	9.19	11.39	8.98	8.98

Tariff Changes over Time**Tariff Changes - Small Domestic Consumers**

Total average tariffs for small domestic consumers have increased very little, in real terms, over the period 1989 to 1993 (table 1). The average total tariff which was 10.20 cents per KWh in 1989, was 10.33 cents in 1992 and 10.88 cents in 1993. The *average fixed costs* per month, however, have increased from \$9.71 in 1989 to \$13.86 in 1992 and \$16.02 in 1993. This change in (simple) average fixed charges from 1992 to 1993 represented a 16% increase, which is very similar to the 19% increase reported by RERC (1994) on a weighted average basis.

The *variability of total tariffs* for small domestic consumers also did not increase much over this period. The maximum total tariffs charged have only increased from 13.22 cents per KWh in 1989 to 14.38 cents in 1993. The *maximum fixed charges* have, however, increased from \$18.77 per month in 1989 to \$40.69 in 1993. The variability measure in the case of fixed charges thus increased from 4.07 in 1989 to 6.89 in 1993.

Tariff Changes - Medium Sized Farms

Total average tariffs for medium sized farms have actually declined, in real terms, over the period 1989 to 1993 (table 1). The average total tariff which was 13.05 cents per KWh in 1989, was 11.52 cents in 1992 and 11.55 cents in 1993. The *average fixed costs* per month, however, have increased from \$10.60 in 1989 to \$15.55 in 1992 and \$21.58 in 1993. This change in (simple) average fixed charges from 1992 to 1993 represented a 39% increase, which is much lower than the 82% increase reported by RERC (1994) on a weighted average basis.

The *variability of total tariffs* for medium sized farmers also did not increase much over this period. The maximum total tariffs charged decreased from 17.95 cents per KWh in 1989 to 16.77 cents in 1993. The *maximum fixed charges* have, however, increased from \$27.31 per month in 1989 to \$70.43 in 1993. The variability measure in the case of fixed charges thus increased considerably from 4.98 in 1989 to 14.02 in 1993.

Tariff Differences by Regions and Ownership Structures

Regional differences in both total tariffs (cents per KWh) and fixed charges (\$ per month) between urban/suburban and rural power company regions is generally accepted as a reality. Table 2 summarises the tariffs for 14 predominantly *urban* (eg, Mercury Energy-Auckland) and *suburban* (eg, Electro Power-Palmerston North) power companies, 6 mainly *remote rural* (eg, Eastland-Gisborne, West Power-West Coast) companies and 11 power companies (eg, Power NZ-Thames Valley, Trust Power-Tauranga) which have adopted a long term *trust ownership structure*.

Tariff Differences - Small Domestic Consumers

In 1989, *average total tariffs* for small domestic consumers were 10.32 cents per KWh in the rural regions and 10.20 cents in the urban/suburban regions, while it was 10.44 cents for regions now run by trusts. In 1993, average total tariffs were 11.28 cents per KWh in the rural regions and 10.89 cents in the urban regions, while it was 10.81 cents for regions

run by trusts. This represented a 9% increase for remote rural areas, a 7% increase for urban and suburban regions and a 3.5% increase for trust managed regions (table 2).

In 1989, *average fixed costs* for small domestic consumers were \$12.19 per month in the rural regions and \$8.75 in the urban/suburban regions, while it was \$9.47 for regions now run by trusts. In 1993, average fixed costs were \$19.51 per month in the rural regions and \$16.69 in the urban regions, while it was \$15.68 for regions run by trusts. This represented a 60% increase for remote rural areas from an already higher base (\$12.19 per month), a 90% increase for urban and suburban regions from a lower base (\$8.75) and a 65% increase for trust managed regions (table 2).

Similar tariff changes over time and relativities between regions and ownership structures have also been reported for the medium sized farms in table 2.

Other Electricity Reform Issues

Some other important issues related to electricity industry reforms deal with *energy efficiency* measures, *renewable energy development* and the *environmental impacts*. All these issues are more or less inter-related.

Promoting energy efficiency within the industry and by the consumers of electricity is a stated goal of energy reforms. Implementation of this goal, however, has been difficult due to the direct conflict of energy company sales and profits with energy efficiency and conservation. An *Energy Efficiency and Conservation Authority (EECA)* was formed by the government in 1992 to facilitate this objective of the reforms.

The Government has recently announced a *10-point plan* to implement an integrated conservation strategy to foster energy efficiency across all fuel types and key sectors. It has allocated \$8.45 million, over a three year period, for this strategy which is to be implemented by EECA.

Renewable energy developments such as *wind turbines* and *solar panels* have improved in cost effectiveness due to the advancements in technology in these areas. These generation processes are, however, still *more expensive* than electricity from hydro systems and even diesel generators. They nevertheless have a lower or minimal *impact on the environment* in terms of carbon dioxide emissions in comparison to the processes burning fossil fuels.

IMPORTANCE OF ELECTRICITY FOR THE AGRICULTURAL SECTOR

Electricity is used by the farm sector, in agricultural processing and in the transport of some raw and processed products.

On-Farm Electricity Use

Total *agricultural electricity use* is only about 2.5% of total national demand. During the 1970s, electricity consumption in agriculture increased by about 3% per annum. Since 1977 however, all growth in electricity demand was attributed to the rapid increase in sprinkler/spray irrigation and associated water pumping. Non irrigation electricity demand

had stabilised in the early 1980s and there has been no significant demand increases for irrigation since the mid 1980s.

Electricity also accounted for only 5% of the *total energy inputs* to New Zealand agriculture or 12% of the direct energy input. About two-thirds of the electricity was utilised to run induction motors powering pumps used for irrigation and stock watering, and compressors used in refrigeration and cooling. Other uses included water and space heaters, shearing machines, electric fences, conveyors and greenhouses, as well as lights.

On average, farmers paid a *price for electricity* which was similar to typical "commercial" tariffs. These rates were and still are more expensive than domestic or industrial tariffs. They were set to reflect the higher supply distribution costs to rural areas and the low plant factors typical of many farming applications. Farm tariffs had also varied enormously, much more than the domestic tariffs, between various supply authorities.

While electricity usage and thus costs are relatively small overall, a large *proportion of electricity demand* is derived from a relatively small number of farmers. It is estimated that about 25% of all the farmers who either irrigate and/or are involved in dairying accounted for about 75% of the total electricity use on farms (New Zealand Energy Research and Development Committee, 1983). On average, about 2.0 - 2.9 KWh of electricity was used in the production of a kg of milkfat on dairy farms. Annual level of consumption of the above 25% of farmers was over 15,000 KWh.

In a *dairy* enterprise, electricity is used by the milking plant, by the refrigerators used for cooling milk, by motor pumps used in irrigation and effluent disposal and by water heaters, electric fences and lights. The cost of electricity on dairy farms, excluding for irrigation, is about 5-6% of the total operating expenditure. Level of electricity use is about 15,000 KWh per annum.

In a *sheep and beef* enterprise, electricity is used for the shearing plant, the dipping plant and for the water pumps and lights. Cost of electricity as proportion of total operating costs varies between 1.5-2.5% (Hill country) and 3.0% (Dryland). Level of electricity use also varies between 2,500 and 3,000 KWh. It is worth noting this relatively low level of usage tends to be spread over several points of supply. As a result, sheep and beef farms will tend to be more disadvantaged than other farm types by the move to increase supply charges and reduce energy costs.

In a fully developed *orchard* enterprise, electricity is used for the refrigerators used for cooling fruit, for processors and graders, water pumps and wind machines used in irrigation and frost protection and by lights. The cost of electricity is about 1.0-1.5% of the total operating expenditure and the level of electricity use is about 7,000 KWh per annum.

In an *irrigated mixed cropping* enterprise, electricity is used mainly for the motors driving the irrigation water pumps and other accessories, augers and other equipment used in grain handling along with shearing and dipping plants as appropriate. The cost of electricity, including for irrigation, is about 10-15% of the total operating expenditure and the annual level of electricity use can exceed 50,000 KWh on a dry year.

An important aspect of electricity usage is the load demands placed on the system. The *peak demand* periods for farming occur over the summer, based on peak milk flows on

dairy farms and peak irrigation and stock water demands. Peak demands on the national electricity system however, occur during the winter months of June and July. Farming loads therefore, contribute little to peak system load over this period. In some regions such as Canterbury however, load requirements for irrigation pumping significantly contribute towards summer peaks and thus incur excess load costs.

Off-Farm Electricity Use

This section attempts to provide some *perspective* on the level and cost of electricity use by different agricultural processing activities in New Zealand. It is based mainly on personal contact with industry and other sources and are such attributed to the sources. They are often not based on a scientific survey of all major processing operations across the country.

Electricity is used in the *processing* of agricultural products such as milk powders, casein, cheese and butter in the dairy industry, by the freezing works in the meat industry, by grain and flour millers in the milling industry and by coolstores and packhouses in the fruit industry. It is also used to some extent by the domestic *transport sector* especially the train cargo service.

Dairy Processing

Among the different off-farm uses of electricity, dairy products processing is quite *electricity intensive* to the extent that major dairy processing companies are considered as major users by the electricity industry (personal communication, Sandy Murdoch, Tui Milk Products Ltd). Among the dairy products, manufacture of *casein* (615 KWh per tonne) and *wholemilk powder* (270 KWh per tonne) are the most electricity intensive followed by *cheddar cheese* (100 KWh per tonne) and *butter* (85 KWh per tonne).

The *cost of electricity* as a percentage of total manufacturing costs vary between 2-3% (for cheese and butter) and 6.5-7% (for casein and wholemilk powder). Electricity cost as a percentage of total energy costs varies between about 25% (for butter and powder) and 35% (for casein and cheese).

Meat Processing

During the 1970s, several *technical factors* contributed to the increase in energy use per production unit, particularly for electricity. These factors included stricter hygiene requirements, further processing of meat, mechanisation, automation of controls and rapid increases in refrigeration (New Zealand Energy Research and Development Committee, 1975).

It was also reported then that South Island works used more fuel and less electricity per kilogram of meat processed. This was attributed to the greater use of electricity in the refrigeration of beef carcasses more prevalent in the North Island. Fuel and power accounted for about 5% of total operating costs in 1975.

In 1988 (most recent year for which compiled information is available), *total energy costs*, including electricity, coal, gas, oil, diesel and petrol as a percentage of total processing costs was 5.7% (personal communication, Chris Jackson-Jones, Meat Industry

Association). Electricity was the *main energy source* accounting for about 3.8% of total processing costs.

In *commercial cold storage* of agricultural products, electricity cost is estimated to account for about 14.5% of total operating costs and about 8% of total gross revenue. Electricity is used for the refrigeration plants and fans, for water pumps in the coolants and some for office use (personal communication, John Oliver, Lincoln University).

Grain Processing

Electricity costs in *grain drying* installations can vary between 8% and 15% of total operating costs depending on the *moisture content* of grain in the different seasons as electricity usage is related to the extent of re-conveying and fan running time involved (personal communication, Bruce Withell, Agriculture New Zealand, Palmerston North). Electricity use in flour milling is reported to cost about \$6.50 per tonne of processed flour.

Fruit Packing and Storage

Electricity costs for *coolstores* are about third in the order of importance in the total operating costs of coolstores next to labour and repairs and maintenance. It accounts for about 9-24% of the costs of coolstore operations. It is reported that electricity costs are around \$10-\$10.50 per pallet of static capacity in cool stores where a pallet contains 180 trays of *kiwifruit* (personal communication, Ruth Underwood, Agriculture New Zealand, Tauranga).

IMPACTS OF THE REFORMS ON RURAL COMMUNITIES

As discussed, the bulk of electricity industry reform decisions taken so far have occurred mainly in the *distribution and retail sectors*. The impact of these reforms in general has been discussed in Section V. In this section, the impacts on rural consumers specifically are drawn out.

The concerns of rural electricity consumers mainly fall into two areas - *cost*, and *supply*.

Electricity Cost

Rural electricity consumers are facing higher charges for electricity from two sources. Firstly, *tariff rebalancing* is reducing or eliminating the historical cross-subsidisation of domestic consumers by commercial users. This impact is shared both by rural domestic consumers and their urban counterparts.

Secondly, the *separation of line charges and actual energy costs* means that rural consumers are having to pay more of the true costs of getting the electricity to them. Historically costs of supply have tended to be averaged over all users, with the result that urban users were subsidising rural users. Although some power authorities had implemented an element of fixed charging before the reforms, the fixed charge did not represent the true cost of supply.

Under the new corporate structures for power suppliers, there are strong incentives to achieve a *commercial rate of return* on all assets, including power lines to remote users. While companies may not have faced the true cost of originally providing power lines in such areas, where installation was subsidised by RERC, they now face the cost of continued maintenance and possible replacement.

In addition, the power companies themselves now face separated charging for the electricity they purchase. In addition to the basic cost per unit of electricity, there is a supply charge. Power companies in remote areas such as the East Cape and the West Coast face higher charges to cover both *transmission* over longer distances as well as for higher electricity losses through "*leakage*" en route. As these remote suppliers tend to have a higher proportion of rural consumers, the impact of this will tend to fall more heavily on rural consumers.

It is worth noting that power companies are likely to maintain an element of cost averaging, mainly to reduce *transaction costs*. The trend to company mergers already in evidence may put some companies in a stronger position to carry more of the costs of rural supply.

The *latest increase* (November 1992 to December 1993) in average fixed charges was about 19% for all domestic consumers (RERC Tariff Monitoring Report, 1994). This suggests that the increase in predominantly rural areas was probably much more than 20%. The average total real electricity costs however, increased by less than 1% due to some offsetting decreases in energy charges.

Actual increases for individual power company supply regions are quite different. The power companies which have adopted an ownership/management structure involving long term trusts have increased both fixed charges and total charges by a lesser amount than those with other structures, perhaps indicating a willingness to accept a lower rate of return.

The Electricity Act of 1992 provides some powers to *regulate* domestic electricity *prices*, including the level of fixed charges. Current guidelines allow for a maximum annual increases in rural line charges of 15%, so that full line tariffs for rural consumers will be phased in over time.

These regulations *apply to line charges* and not fixed charges (as explained above, these are not the same thing) and also protect domestic rural consumers only. The limit on price increases is due to expire in 1998.

Electricity Supply

There are two elements to electricity supply. The first is *access* to the distribution network, while the second is the *quality* of electricity provided.

The Government has indicated its desire to maintain the current 'universal' electricity supply. Under the Electricity Act it is an offence for line distribution companies not to maintain connections existing at the date of vesting. *Fines* up to \$10,000 can be applied for each connection lost. The *exceptions* are agreement with individual consumers, consent from the Minister of Energy, non-payment of bills or safety reasons.

Nevertheless, ensuring the maintenance of electricity supply of satisfactory quality and reliability into the future could be difficult, due to the *lack of maintenance* of lines for a considerable period of time in many cases. There is considerable uncertainty, therefore, as to how the 'uneconomic' lines will be handled by the newly established power companies with corporate ownership and management structures.

In remote areas power cuts or "brown-outs" may occur more often if maintenance on sparsely populated or less economic lines is cut back. Under the *information disclosure* regime, however, the new power companies are required to disclose in each year's accounts the liability carried forward for replacing "uneconomic lines". They also have to publish information on prices, terms of conditions of supply, and on a number of performance measures including the frequency of power cuts.

It is also conceivable that the *threat of competition* from alternative suppliers would act as an incentive to provide a satisfactory quality of supply. However, rural consumers, particularly in remote areas, are unlikely to constitute attractive targets for competing suppliers. For rural consumers, having a choice of supplier is likely to remain more theoretical than real.

Very remote electricity users may eventually find the cost of electricity from the National Grid increasing to the point where it is more economical to run a *stand-alone power system*. This could be diesel generators, wind turbines, solar panels, geothermal, small private hydros and other hybrid forms. Advances in such systems, especially in mini hydro systems, are being made all the time.

With removal of the monopoly on power generation by ECNZ, many power companies have been planning to set up their own generating plants. In addition to helping lower electricity costs, particularly at peak demand times, this diversification should also reduce the vulnerability of regional consumers to disruptions in the national power supply.

Other Changes

Individual customers are now responsible for the cost of *maintaining lines* and poles within their properties (service lines) as well as lines to the nearest customer (distribution lines). In rural areas, service lines in general and distribution lines in particular are much longer than for their urban counter-parts. Although this provision has been in place since 1984, many companies have absorbed this cost until now. In future, however, they are likely to recover at least some of this cost from their customers, especially those in remote rural areas.

The new Electricity Act also allows customers to carry out much of their own *electrical work at home*. Work has to be inspected by qualified personnel before the power is turned back on. To the extent that rural dwellers are more able than their urban colleagues to do their own repairs, this could represent a significant opportunity for saving.

RERC's Role after the Reforms

RERC took over the role of *monitoring electricity tariffs* in 1992, when Government decided to disband the Electricity Distribution Reform Unit (EDRU). RERC was also charged with the responsibility of *receiving and researching concerns* raised by rural

electricity consumers and channel legitimate concerns to the appropriate authorities for suitable recourse.

The *term* of RERC was fixed for *five years* from the date of implementation the Electricity Act of 1992. It was anticipated that the adverse impacts of the reforms, if any, would have been encountered by rural consumers by then.

The RERC will, for a fee, investigate rural electricity supply problems. This could include significant increases in total electricity tariffs or adverse changes in the quality of supply. So far, very few rural consumers have reported problems to the RERC. This could be due in part to the limited publicity of RERC's existence and its role.

SUMMARY OF ELECTRICITY REFORMS AND IMPACTS

Electricity reforms are part of the overall *energy sector reforms* undertaken by the government. It is one of the last in the series of key sectors of the economy reformed since 1984. The reform process in the electricity industry is far from over, and any analysis of the impacts of reform is necessarily *preliminary*. Although reforms in the distribution and retail sector are well advanced, they await developments in the generation and transmission sectors to become fully functional. Reform in these two latter sectors has been slow to date. The development of a wholesale electricity market is a key missing component so far.

The evidence suggests that commercial users of electricity, including *agricultural processing industries*, will benefit from the rebalancing of tariffs and the reduction of cross-subsidisation of domestic users. Many agricultural processing industries are reasonably intensive users of electricity, and already benefit from the lowest electricity charges in the OECD. To the extent that agricultural processing occurs in regional locations, they may face higher supply costs due to differential charging by TransPower. On the other hand, the removal of franchise areas means that, as large users of electricity, they may be able to negotiate a bulk electricity deal from either their local supplier or a competitor.

On farm, the impacts on the business side will be similar to the processing industry, except more remote locations will mean higher supply costs. Smaller size will also limit the possibility of negotiating deals with suppliers. However, there may be scope for farmers to arrange a collective agreement with a supplier, similar to "clubs" which currently operate for fuel and other inputs. As more intensive electricity users, *dairy farmers* may benefit more from the rebalancing between supply and energy costs. In addition, dairy production tends to occur closer to urban centres and thus may face smaller increases in supply costs.

Users of *irrigation* are the heaviest farm electricity users, and face a potentially large impact from reform. Most irrigation users pay supply charges all year for energy used only for a short period. Where this demand coincides with local peak demand, energy costs could be high. This, combined with the prospect of increased water charges and other requirements under the Resource Management Act, may make irrigation uneconomic on some farms.

Rural domestic users face the largest change under the reforms. The rebalancing of tariffs from urban to rural users, and from commercial to domestic users, hits this group twice. In addition to concerns about cost increases, there are also concerns about the quality and availability of supply. However, there are some protective measures in place which should limit the negative impact for rural domestic consumers in the short term - the limit on increases in line charges to 15% p.a; the penalties for disconnecting service; and the availability of RERC to investigate any cases of hardship created by the reforms.

In the longer term, particularly as the demand for electricity grows and more expensive sources are utilised, it may become more economic for remote users to use *alternative sources of power*. Technological improvements are making such systems more reliable and less costly. However, the loss of remote customers on some lines may cause currently economic customers to become uneconomic. It is difficult to assess how significant this "snowball" effect may be overall.

Ultimately, the reforms undertaken in the electricity sector to improve the efficiency and the investment decisions in that sector will impact on the *investment decisions in other sectors*. In farming, the electricity reforms impact on both the business itself and the associated farm household. Electricity is one of several services which have, or are likely to, become more expensive in rural areas in the environment of deregulation, privatisation and user pays. In some areas, facing the true cost of supply for services may start to impact on overall *land use decisions*. Farming may become concentrated in areas closer to services, while in more remote areas, land uses which do not involve residence, such as forestry, may become more attractive.

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APPENDIX 1

CONFERENCE PROGRAMME

NEWSLETTER

JUNE 1994

CONFERENCE PROGRAMME

1-2 July 1994
Blenheim Country Lodge
cnr Alfred and Henry Streets
Blenheim

1984 - 1994: Ten Years of Progress?

Friday, 1 July 1994

12.00 noon	Lunch provided for all Registrants (included in Registration Fee)
1.00 pm	Welcome and Conference Opening <i>Frank Scrimgeour</i> , President, NZAES
1.10 pm	Plenary Session - Chairperson: <i>Frank Scrimgeour</i> Speakers: <i>Arthur Grimes</i> on Monetary Deregulation <i>Basil Sharp</i> on Resource Management Issues <i>Ron Sheppard</i> on Agricultural Matters
3.00 pm	Afternoon Tea
3.30 - 5.00 pm	Contributed Paper Sessions (Two Concurrent - 3 papers in each at 30 minutes each) (See Separate Programme)
5.30 pm	NZAES Annual General Meeting (See Over For Agenda)
6.30 pm	"President's Shout"
7.30 pm	NZAES Conference Dinner

NZAES Secretariat, Mrs Jan Clark, Telephone (64) (3) 325-2811, FAX (64) (3) 325-3847

Affiliated to the Australian Agricultural Economics Society (Inc.)

New Zealand Agricultural Economics Society (Inc.)
C/- Agribusiness and Economics Research Unit
PO Box 84, Lincoln University
Canterbury, New Zealand

Saturday, 2 July 1994

- | | |
|------------|--|
| 9.00 am | Contributed Paper Sessions (Two Concurrent - 3 papers in each at 30 minutes each) (See Separate Programme) |
| 10.30 am | Morning Tea |
| 11.00 am | Plenary Session - Chairperson: Sandra Martin |
| | Speakers: |
| | Peter Lloyd on "An International Perspective" |
| | Graham Robertson on Farming and "The Way Ahead" |
| 12.00 noon | Conference Closure followed by Lunch (included in Registration) |
-

NZAES ANNUAL GENERAL MEETING

(5.30 pm 1 July 1994)

AGENDA

1. Apologies
2. Minutes of the 1993 AGM
3. Matters Arising
4. President's Report
5. Treasurer's Report
6. Election of Officers for 1994/95
7. 1995 Conference
8. General Business
 - Constitution
 - Fellows
 - International Agricultural Economics Society Conference - travel assistance

NZAES Secretariat, Mrs Jan Clark, Telephone (64) (3) 325-2811, FAX (64) (3) 325-3847

Affiliated to the Australian Agricultural Economics Society (Inc.)

CONTRIBUTED PAPER SESSIONS

Friday, 1 July

3.30 - 5.00 pm

Contributed Paper Sessions (Two Concurrent - 3 papers in each at 30 minutes each)

Session 1

Caroline Saunders - Changing Emphasis of Agricultural Support Towards Provision of Public Goods in the Countryside: UK Perspective

Paul O'Neil - Has The Resource Management Act Killed Zoning?

Session 2

R Brazendale & W J Parker - Responses of Selected Wairarapa Sheep and Beef Cattle Farmers to Changes in Government Policy.

Ram SriRamaratnam & Jagdish Prasad - Beef Production from Dairy Beef vs Beef Cattle: Changing Responses to Manufacturing and Prime Beef Price Relationships.

Frank Scrimgeour - The Economics of Farm Forestry: Some Empirical Estimates

Saturday, 2 July

9.00 - 10.30 am

Contributed Paper Sessions (Two Concurrent - 3 papers in each at 30 minutes each)

Session 1

Greg Brush and Michael Clemes - Your Money or Your Life

Robin Johnson - Interest Groups, Pressure and Policy Determination

H Talgaswatta & B D Ward - Measuring Efficiency with Stochastic Frontier Production Function Approach: An Application to Rubber Estates in Sri Lanka.

Session 2

Petrus Simons - Patenting Genetically Modified Organisms: The Case Against.

Glen Greer - Evaluation of Changes in Water Availability for Canterbury Irrigators

Ram Sriramaratnam & Margaret Wheatstone - Electricity Industry Reforms: Impacts on the Agricultural Sector and the Rural Communities.

APPENDIX 2

LIST OF PARTICIPANTS

LIST OF CONFERENCE PARTICIPANTS

Alexander, Dr Rob, Massey University
Bailey, Professor William, Massey University
Banks, Mr Tony, Massey University
Bicknell, Katie, Lincoln University
Brush, Mr Greg, Lincoln University
Burdon, Bruce, MAF Wellington
Butcher, Mr Geoff, Christchurch
Cairns, Mr Ian, MAF Wellington
Davison, Mr Rob, NZ Meat & Wool Boards' Economic Service
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