A STUDY OF THE DETERMINANTS OF FATTENING AND GRAZING FARM LAND PRICES IN NEW ZEALAND, 1962 TO 1983

by

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PREFACE

The relationship between economic variables and the price of land has been the subject of a variety of studies which have sought to explain the causes of land price changes. In New Zealand, few of these studies have been carried out in spite of the large movements in land prices which have occurred and the popular conception of linkages between land prices and Government agricultural assistance policies.

The study presented in this Research Report provides a comprehensive review of the theories put forward to explain land price movements and applies the models which those theories develop, to the New Zealand situation. This work will be seen as a significant step towards explaining the movements in land prices with respect to the causes of those movements. The results presented in this Report will enable a much improved analysis of the potential impact of any future Government policy actions and provide a valuable contribution to the "bank of knowledge" pertaining to the agricultural sector.

This Research Report is a reduced version of the thesis presented by Peter Seed as part of his required work for a Masterate in Commerce (Agriculture) at Lincoln College.

J G Pryde
Director

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CHAPTER 1

INTRODUCTION

During the late 1970's and early 1980's, the price of sheep and beef farms in New Zealand increased rapidly. From 1962 to 1983 the fattening and grazing land price indicies compiled by the Valuation Department increased at an annual compound rate of 12.4 per cent. Over the same period the Consumer Price Index (CPI) increased at an annual compound rate of 8.6 per cent. This phenomenon has not been confined to New Zealand. In fact, the movement in New Zealand farmland prices appears to be lagged one to two years behind similar movements in United States farmland prices. Feldstein (1980b) has pointed out that although one would expect a priori that land and other real assets would hold their real value as the price level rises "... the increase in the relative price of land caught economists as well as others by surprise".

Little empirical work has been done in New Zealand to investigate the causes of these large increases in land prices. Apart from Leathers' and Goughs' (1984) bid price model and Johnson's (1971) bivariate model no other empirical studies using specifically New Zealand data were found during the literature search for this study. Despite this dearth of analysis one may still read that:

> "..., perhaps the most general and most important single explanation for the buoyancy of farmland prices (is) as a hedge against inflation. And underpinning all of this has been the massive increase in government subsidies to farming during the 1970's - an increase largely capitalised, as windfalls always are in New Zealand, into higher land prices."
>
> (Gould 1982; p 163 emphasis added)

or that:

> "The borrower benefits from the subsidised interest rate which is paid for by taxpayers in the form of interest forgone. Also, insofar as the availability of cheap credit puts upward pressure on land prices, established farmers receive benefits in the form of tax free capital gains."
>
> (Treasury 1984a; p 19)

With regard to the second point, Stewart et al (1985) have commented that according to a recent study by Leathers and Gough (1984) the "variable which has the "greatest influence on the bid value" for farms is the general inflation rate and the expectations as to inflation", (p.29). Stewart et al also point out that the Leathers and Gough study emphasises the need for a more "studied approach to the argument that assistance measures are quickly capitalised into farm asset values". (p.30) Thus the primary objective of this study is to examine the veracity of the theories that have lead Gould (1982), Treasury (1984a) Stewart et al (1985) and others to draw the conclusions that they have. More particularly, the study aims to examine the relationship between real land price and expectations of real income, real capital gains and the rate of inflation for sheep and beef farms over the period 1962 to 1983.

CHAPTER 2

LAND PRICE ISSUES

2.1 The Problem

In 1979, Melichar summarised the situation facing agriculture in the United States as follows:

> "Given a growth rate of 4 per cent to 5 per cent in the constant dollar current return to assets, the farming sector is doomed, at likely discount rates, to a relatively low rate of current return on the market value of assets. This inescapable consequence is the common root of many of the farming sector's current problems: cash flow difficulties; large increases in debt; troubles of beginning farmers; the attraction of farm real estate for persons of large wealth or high income - all of these stem from the fact that at such a growth rate, a significant proportion of the total return to farm real estate necessarily takes the form of capital gains." (p.1091)

This situation has characterised agriculture not only in the United States but also in New Zealand. During the mid to late 1970s the New Zealand government embarked on the type of policy intervention which Melichar hypothesised would result in a low percentage rate of return and high capital gains. The justification for such a policy was to overcome cash flow difficulties and to "shield farmers from a potentially severe income drop" Muldoon (1982). Melichar asserts that the longer term effects of such policies are not to increase the profitability of farming but to rather "increase the degree to which profit takes the form of capital gains rather than current return". (p.1091).

In a later paper Melichar (1983) also reflects on the fact that the preservation of the wealth created by the process described above is dependent upon continued earnings growth. As highlighted, the processes which lead to large capital gains "are just as powerful when they operate in reverse, producing relatively enormous real capital losses when real earnings stop growing or decline". (p.4) Furthermore the upward land price spiral which occurred in the United States and New Zealand in the late 1970's and early 1980's may be likened to a "monster" which required continual feeding to be placated. As he points out

> "If the monster is not fed its expected income growth it soon turns on its owners. As the earnings-growth component is excised from asset value, recent or heavily indebted purchasers of the monster usually experience <u>financial trauma</u>."
>
> (p.5 emphasis added)

From this preceding discussion one may draw some implications for policymakers, at the same time acknowledging the limitations of the partial equilibrium framework in which the analysis is couched. Firstly, if policy makers wish to maintain farm incomes at an "adequate" level, for social reasons or on compassionate grounds, then it should be acknowledged that these policies may be reflected in asset prices. If, as Melichar suggests, the total farming operation behaves as a growth stock, then the outcome of the policy may in fact be immiserising as opposed to beneficial to the group the policy is targeted at.

Secondly the distributional questions are worthy of examination. On one hand there are the intersectoral questions of transfer payments from central government to a specific group and the equity questions which arise there. Moreover, there are the intrasectoral distribution questions. That is, which group or groups within a particular sector "benefit" or "suffer" from a particular policy stance. For example on a falling land market, the economic agents that purchased at the "top" of the market will suffer a loss of equity, while those that sold will have experienced an increase in the value of their equity measured in the amount of land they may now afford to purchase. This leads to the question of whether or not governments should intervene to maintain wealth positions that they may or may not have unwittingly created. This is in essence a property rights question. If due to one policy "set" a group benefited substantially by way of, in this instance, capital gains is it "equitable" that this group, or another group, e.g. new purchasers of land, should now be disadvantaged by an alternative policy "set", which is counter to the first?

Before one may begin to examine these issues, it behoves policy makers to examine the implications of policies that influence farm income levels and in turn the level of asset values.

2.2 Land prices, Income, Capital Gains and Inflation

From 1963 to 1972 the value of nominal total production assets for the Meat and Wool Board's Economic Service (MWBES) "all classes average" increased at an annual compound rate of 5.2 per cent (figure 2.1). Total production assets are comprised of all the assets used in the farming enterprise less the value of the dwelling. The value of the land used by the farming enterprise is the major component of this variable. Over the same time period nominal net income for the same sector (adjusted so as to standardise for ownership) increased at roughly the same rate, that is 5.4 per cent per annum. This is shown in figure 2.3. However, from 1972 to 1982, the situation is reversed entirely. Total production assets increased at an annual compound rate of 18.6 per cent. Over the same period net income increased at 9.4 per cent per annum, twice as fast as it increased over the period

Figure 2.1 Total Production Assets 1962-1983 (Nominal dollars)

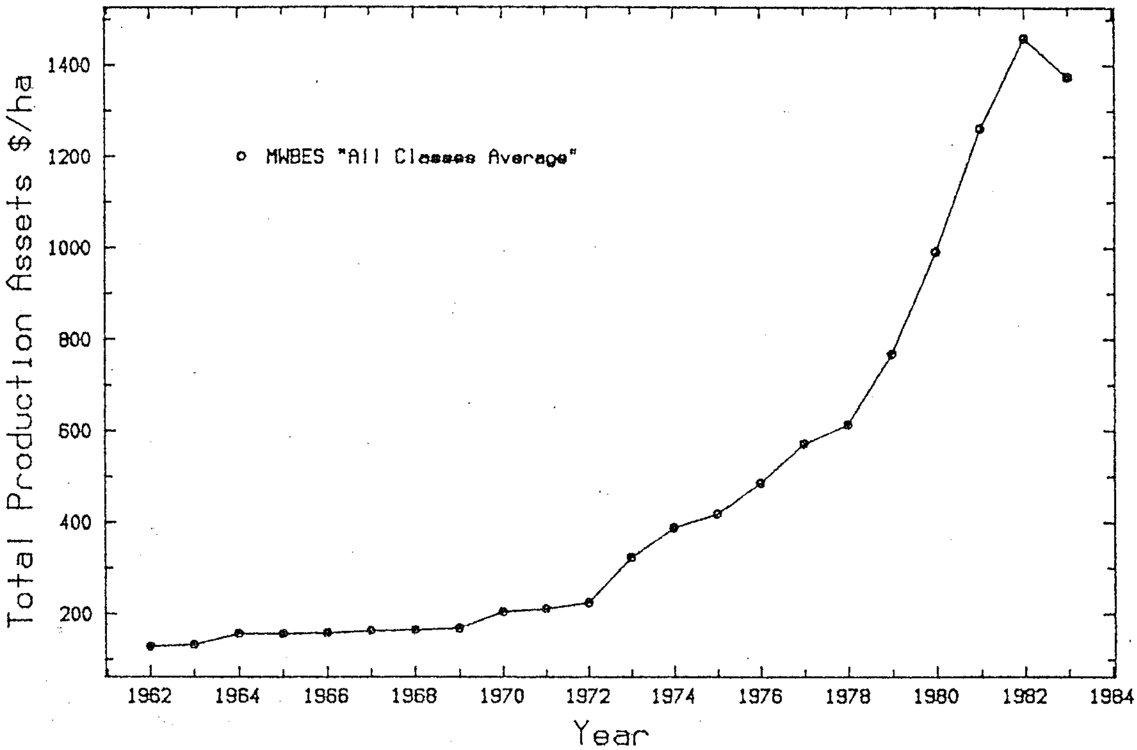


Figure 2.2 Annual Change in the Consumer Price Index 1962-1983

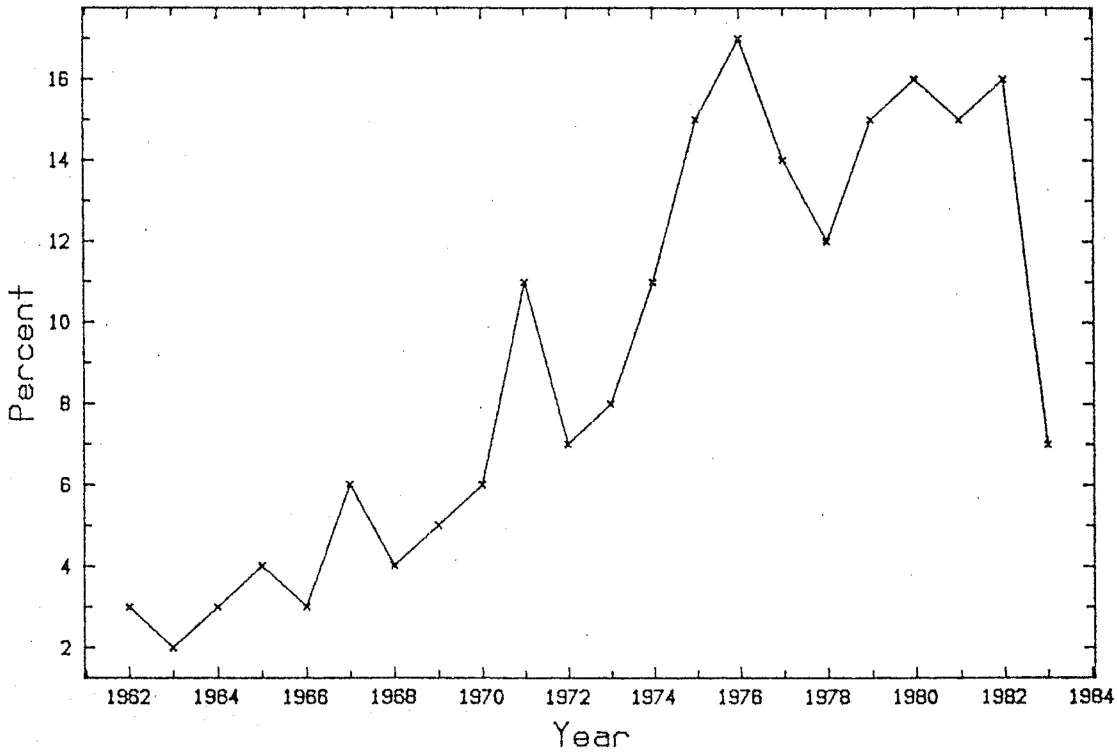


Figure 2.3 Net Income and Capital Gains (Nominal Dollars)

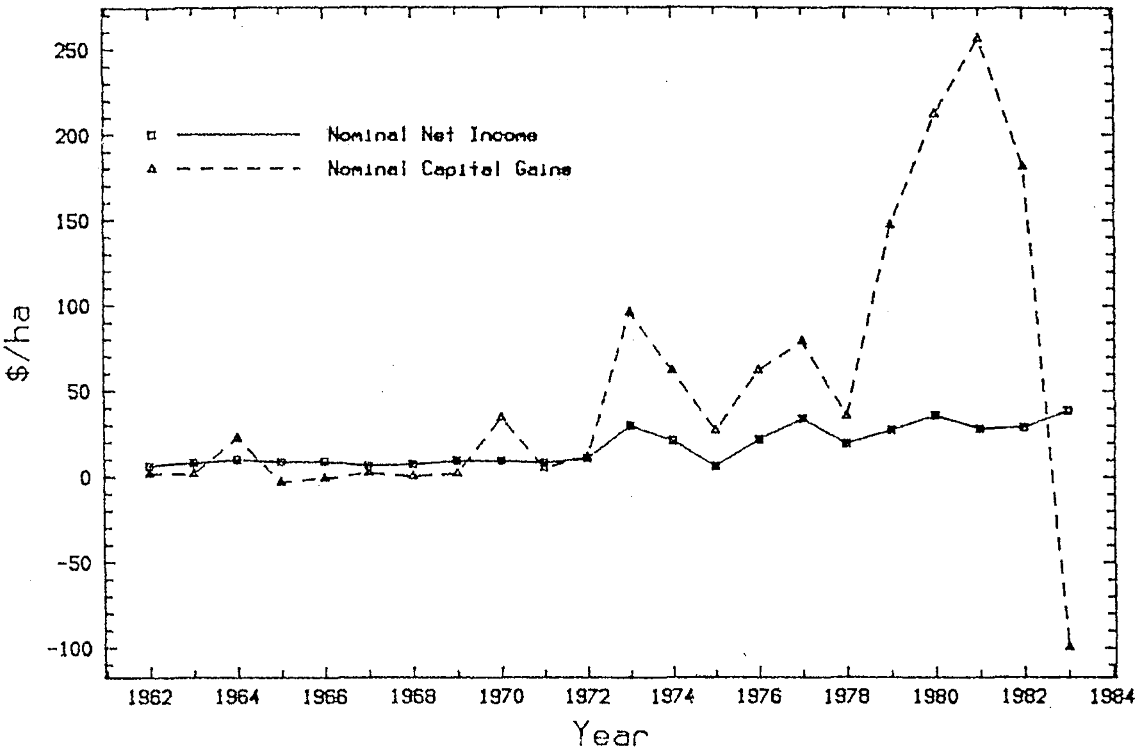
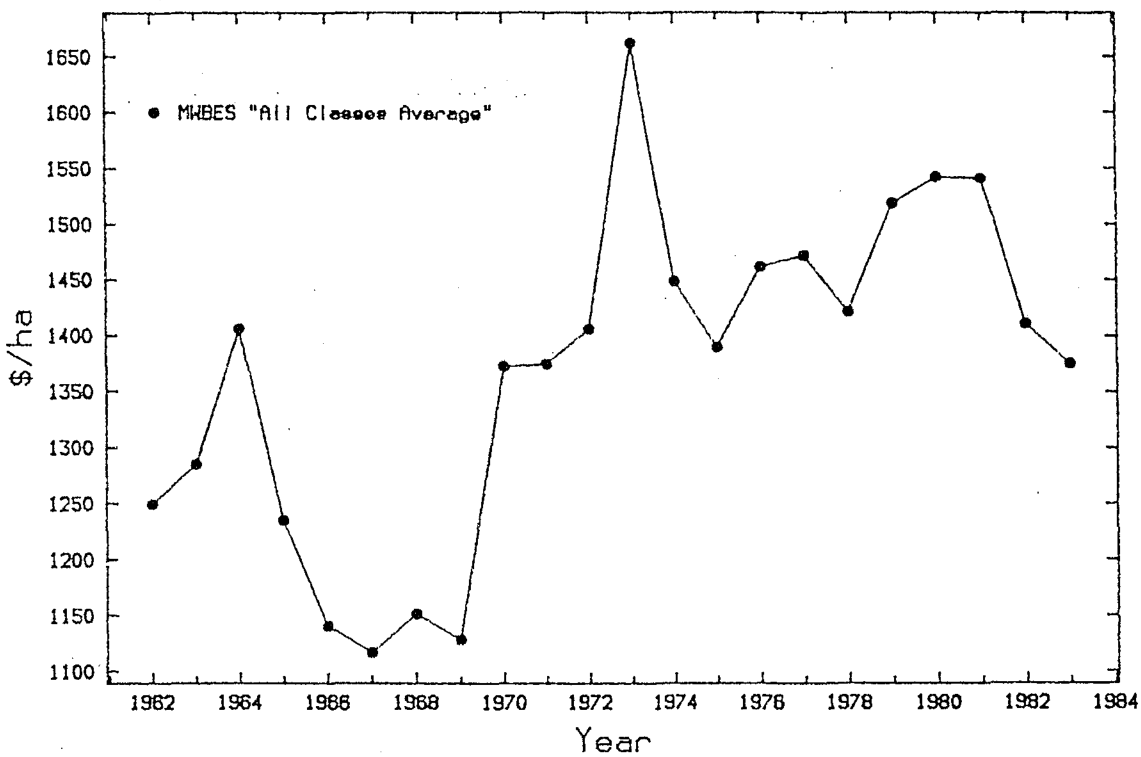


Figure 2.4 Total Production Assets (1983 Dollars)



1963/72 but only half as fast as the rate of increase in total production assets.

By comparison the average annual rate of increase in the CPI over the period 1972 to 1982 was 12.1 per cent (figure 2.2). Also from 1972 to 1982 nominal capital gains as defined by Bhatia (1971) exceeded nominal farm income in nine years out of ten (see figure 2.3). Figures 2.4 and 2.5 depict the same variables expressed in real terms. Real capital gains were calculated as suggested by Bhatia (1971) and the other series have been deflated by the appropriate indices. Unlike the previous series, real capital gains only exceeded real income for four out of the 10 years between 1972 and 1982 and for four of those ten years real capital gains were actually negative. The magnitude of the increases and decreases in farm values is quite surprising. From 1979 to 1983 total nominal capital gains for the 22,000 sheep and beef farms in New Zealand ranged from $3.01 billion in 1981 to an actual capital loss of $1.144 billion in 1983 (Table 2.1).

TABLE 2.1

Nominal and Real Capital Gains for the New Zealand Meat and Wool Sector

Year	Nominal Capital Gains $ million	Real Capital Gains $ million	Real Net Income $ million
1979	1 723	871	444.7
1980	2 500	1 028	339.1
1981	3 010	1 200	416.7
1982	2 088	(247)	574.5
1983	(1 144)	(3 342)	516.5

Source: Seed (1986)

Nominal capital gains that occurred in 1981 amounted to 12.3 per cent of Gross Domestic Product in that year. Also, real capital gains for those years were approximately three times the size of total real income in that sector and approximately two thirds the f.o.b. value of exports from that sector.

Given this situation it is hardly surprising that the term "farming for capital gains" was used by Gould (1982) to describe the motives of some farmers for holding land.

What factors could have contributed to such increases and recently - decreases - in the value of total production assets and the price of land over this period? In commodity, share or foreign exchange markets, the expectations of market participants concerning a commodity's value or the sharemarket's performance are central to the formulation of values. If buyers expectations of income earnings are high for a particular asset, this will be reflected in its price. In "bullish" markets, prices are bid up as economic agents' expectations are high. On the other hand, "bearish" markets tend to claw prices down. What factors lead to the formulation of expectations? A priori one would expect that general economic conditions and intervention by central government would have an impact on the expectations of market participants.

2.3 Factors Influencing Expectations

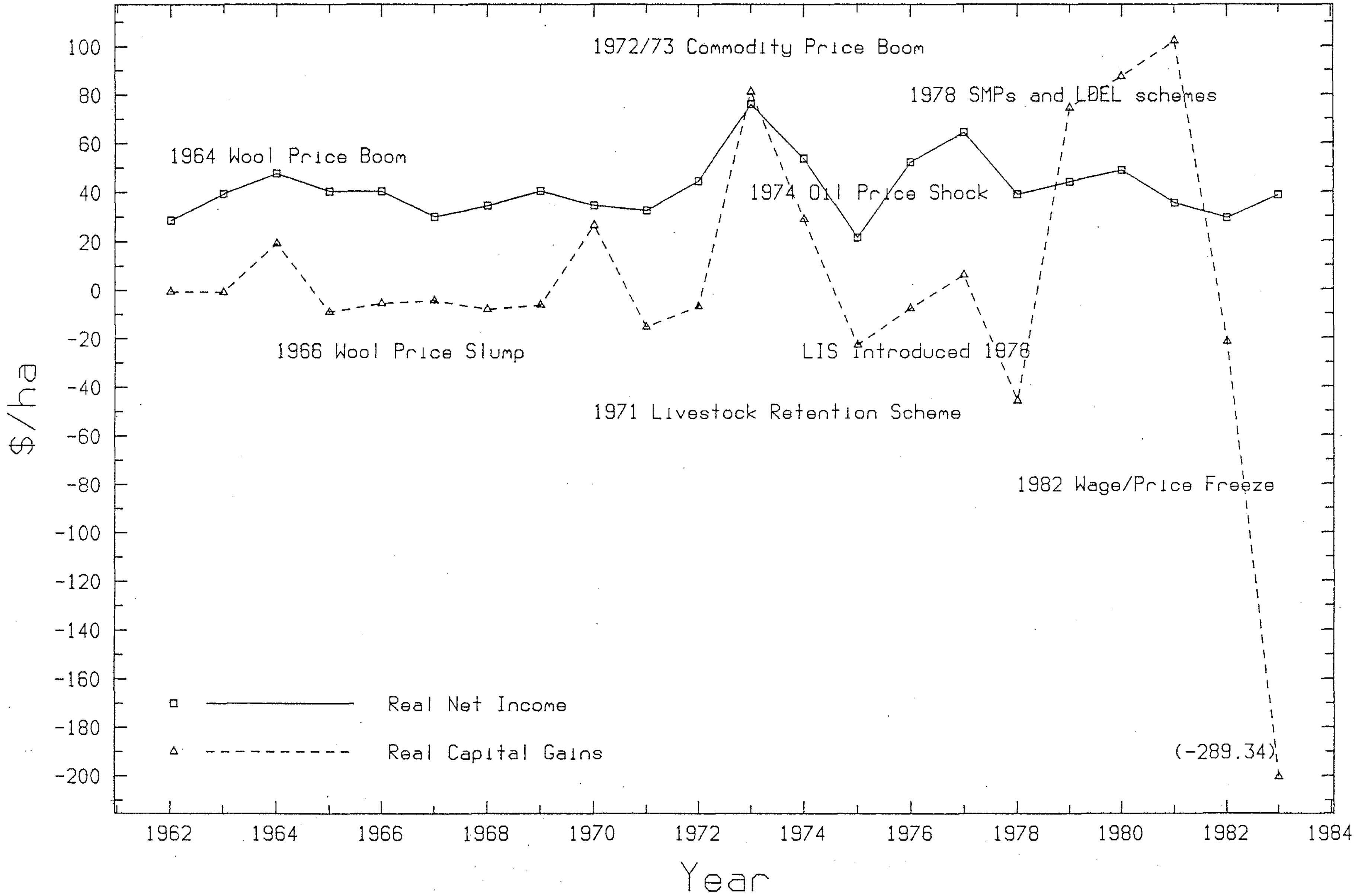
Figure 2.5 depicts real net income and real capital gains over the period 1962 to 1983. As well, it includes a number of "economic signposts" which show some of the significant events that have happened over that time.

Between 1962 and 1967 wool prices rose rapidly and this increase was reflected both in the improved terms of trade and also in higher farm incomes for the years 1963 and 1964. By 1967 however, wool prices had declined to the point where it was necessary for the Wool Commission to intervene in the market by purchasing wool offered for sale. As can be seen from figure 2.5 both net income and capital gains increased sharply from 1963 to 1964 and also declined sharply as prices fell.

During the period 1968 to 1975 real net income and real capital gains were extremely volatile. Real net income rose to a peak in 1973, which has not been surpassed since. Real capital gains also rose sharply in 1973. In October 1973 and January 1974, there were the first of the oil shocks. The terms of trade fell from 124 in the second quarter of 1973 to 70 in the first quarter of 1975, a 44 per cent decrease over a year and a half. This was mirrored in the decline of real net farm income and real capital gains. Between 1968 and 1975, there were also a number of significant policy interventions by central government. These ranged from the introduction of a number of input subsidies in 1969 to the announcement that the government would offer a minimum price guarantee for lamb and wool in the 1974/75 season. In essence, this was the beginning of large scale government intervention in the pastoral agricultural sector, which reached a peak in the early eighties.

The 1976 to 1983 period saw the introduction of three large schemes designated to ensure that;

Figure 2.5 Income and Capital Gains (1983 Dollars)



(i) farm incomes were adequate,

(ii) to "encourage" production in the pastoral agricultural sector, and

(iii) to restore its "competitiveness" as an exporter.

The three schemes were the Livestock Incentive Scheme (LIS), the Land Development Encouragement Loan Scheme (LDEL) and the Supplementary Minimum Price Scheme (SMP).

As tariff compensation measures, the policies were quite powerful. As can be seen, from Table 2.2, the effective rate of assistance to sheepmeat and wool producers increased rapidly from 1978 to 1984.

TABLE 2.2

Effective Rates of Assistance for Sheepmeats and Wool (percent)

Period	1966/67	1971/72	1978/79	1983/84
Sheepmeats	-7.5	-2.0	8.0	80
Wool	-7.5	2.0	-5.0	50

Source: Lattimore (1986)

From 1978/79 to 1983/84, the effective rates of assistance leapt from 8.0 and -5.0 per cent for sheepmeats and wool respectively, to 80 and 50 per cent. Over the same period, nominal land prices increased by an average rate of 18.6 per cent per annum, while nominal income only increased at 9.4 per cent per annum. This would suggest that some other factor or factors, besides income, were "driving" land prices over this period.

CHAPTER 3

AN EXAMINATION OF THE COMPETING THEORIES

In the land price literature, a number of theories of land price determination have been developed. Although most of these are based upon the Ricardian theory of land rent, corollaries to this theory abound. One body of literature has as its main theme the notion that net farm income or similar measures determine the price of land. The key paper here is the work by Melichar (1979). Another theme examines the incorporation of capital gains into the theory, particularly the work by Bhatia (1972) and Castle and Hock (1982). Finally, Feldstein (1980a) developed the hypothesis that inflation leads to increase in the real price of land.

3.1 Net Farm Income

Much of the initial research on farmland prices can be traced back to the Ricardian Theory of Rent. That is, the more productive land is the higher the rent will be. In the long run the higher rent is capitalised into the value of land. Following Doll and Widdows (1982a) rent for agricultural land will be defined as "the excess return above that required for the maintenance, depreciation and interest on buildings and other fixed improvements." In the earlier literature on farm real estate values, net farm income was commonly used as a proxy for rents and this was found to be suitable in the sense that income and land prices seemed to correspond reasonably well. In the late sixties however, researchers noted that this relationship did not appear to hold. Schofield (1961) and Chryst (1965) observed the "Land Price Paradox", where land prices were increasing far more rapidly than increases in income seemed to warrant. In fact, the two variables seemed to be diverging in a scissor like fashion.

During the seventies the literature concentrated upon determining more elegant methods of assessing what rational farm operators would be prepared to pay for farm real estate. Lee (1976) and Lee and Rask (1976) developed and refined a "bid-price" model to evaluate farmland prices and more particularly, to provide the farm operator, land buyer or appraiser with a method of determining the value to that individual of a parcel of land. The model was essentially a capital budgeting model and included in it were such variables as the individual's discount rate, income expectations, credit terms and marginal income tax rate. The model also allowed the buyer to input different operating efficiencies, planning horizons and initial equity positions. The "bid price" equaled the present value of the discounted stream of benefits less the discounted cost stream. Due to the nature and specification of the model it could only really be used as a forecasting tool. The model was extremely sensitive to the rate of inflation in land values due to the way it was specified. It was also possible that the bid price would "explode" as high land price inflation led to higher land prices and this, in turn, fueled even higher land price inflation. Lee and Rask's results indicated that the price paid per acre for land in the United States corn belt could vary three fold depending upon the buyers financial assets and expectations of economic trends.

Leathers and Gough (1984) replicated the Lee and Rask exercise using New Zealand data. Using Meat and Wool Board's Economic Service (MWBES) and Valuation Department data Leathers and Gough attempted to identify the factors or variables that influenced land values of sheep and beef farms in New Zealand. They also wished to examine the impact of "inflationary and non inflationary economic conditions" on land values as well as identifying policy implications. Unfortunately, the Lee and Rask model was not the most appropriate model for these tasks. Lee and Rask's model is a non-parametric deterministic model. That is, there is no relationship estimated between the explanatory variables and the dependent variable (bid price) and as well uncertainty is not included. Most importantly however, how do we know that the Lee and Rask specification best describes the "true" model? Given that the variables have been selected from theory, but are untested, what weight can be placed upon sensitivity analysis when the significance of one variable over another is the result of its mathematical specification?

Harris and Nehring (1976) also developed their bid price model from the capital budgeting model. They state that if prospective buyers are assumed to be decreasingly risk averse over wealth, land will be acquired by those bidders with:

(a) The highest expected before tax income per acre

(b) The lowest variability of before tax income

(c) The largest initial wealth position

(d) The lowest degree of risk aversion

(e) The lowest marginal income tax rate

(f) The lowest rate of time preference (discount rate)

(g) The highest expected rate of growth in after tax income.

It is unlikely that one bidder will have an absolute advantage in all categories, however, their analysis was based upon the notion that the future control of farming was attributed to those farmers with the greatest aggregate bidding potential for agricultural land. The construction of their model indicated that the wealth position, income variability and the degree of risk aversion were important considerations in the matter of ownership and control of farmland.

Of the recent literature on land prices the paper that has provoked the most discussion has been that by Melichar (1979). Melichar questioned the income/land price paradox argument by first querying the data series used in past land price research and then by pointing out that capital gains over the period could be explained by the growth exhibited in the current return to assets. Early researchers into the determinants of land prices made two important assumptions:

(i) Net farm income was the appropriate measure of the farming operation's income, and,

(ii) V = R/d was the appropriate equation to compute the present value, V, of an input that earns R dollars per period with a discount rate of d percent per period.

Melichar pointed out several shortcomings of these assumptions. Firstly, an aggregate return is being compared to a unit price. That is, aggregate income is being compared to the price of land. Secondly, the aggregate return is being regarded as a return to real estate alone and not to other productive assets. That is, rents and interest on debt that are paid should be added back to net farm income to give a more appropriate measure (pp 1086-7). Also, previous analysts overlooked the substitution of labour for capital. As the amount of labour used declined, the share of returns earned by capital increased.

Most importantly, Melichar advocated the use of a constant growth dividend model. Melichar used this model to demonstrate that a constant percentage growth in the value of Total Production Assets could be attributed to an <u>equal</u> and <u>constant</u> percentage growth in the income produced by these assets.

The constant growth dividend model can be written as:

$$V_0 = \frac{1 + g}{1 + d} R_0 + \frac{1 + g}{1 + d} V_0 \qquad (3.1)$$

and

$$V_0 = \frac{1 + g}{d - g} R_0$$

and where $R_1 = (1 + g) R_0$

then $$V_0 = \frac{R_1}{d - g} \qquad (3.2)$$

where V_0 = Present Value of Land.

R_0 = Present Earnings of the Asset.

R_1 = Earnings of the Asset in the period t + 1.

g = Constant growth rate.

d = discount rate.

Using this model, Melichar was able to show that farm asset values in the United States had risen at about the same rate as the income earned by those assets. And, both earnings and land prices had actually risen faster than the rate of general price inflation.

Capital gains can be seen to occur in two ways.

(i) Either by changes in R, g or d resulting in a new value for V_0, or,

(ii) If the growth rate g is greater than zero the equilibrium value V_0 rises each year even though the values of g and d are unchanged.

Melichar's growth model hypothesis was further discussed by Harris (1979), who agreed with Melichar that the valuation of land was analogous to the valuation of growth stocks. A growth stock being an asset that has the following characteristics:

(a) Rising real income.

(b) The value of the asset rises by the same proportion as the income earned by the asset.

(c) The rate of return of income is relatively low because its value reflects expectations that income will continue to rise.

The yield of a growth stock may be decomposed into two parts. Firstly, a dividend yield that is the income component and a capital gains yield that is realised upon the sale or salvage of the asset. The general growth stock model is defined by Doll and Widdows (1981, 1982b); Harris (1979) and Vandeveer (1985) as

$$V_n = R_o \frac{(1 + g)}{(1 + d)} + R_o \frac{(1 + g)^2}{(1 + d)^2} + \ldots$$

$$\ldots + R_o \frac{(1 + g)^n}{(1 + d)^n} \qquad (3.3)$$

where V_n is the initial value of the asset, R_o is the initial current return, d the discount rate, and g the growth rate in R_o.

The model proposed by Melichar was a restricted form of the general growth stock valuation model. The rate of increase of the current return to assets or rent was restricted to equal the growth rate in the asset value, i.e. the value of land. The validity of the use of this model in explaining movements in the price of land turns on the restriction that the growth rates of the current return and the asset value are constant and equal.

Harris (1979) states that Melichar's evidence of land values and income is consistent with the growth model formulation and that ad hoc explanations of the divergence between income and land value may be misdirected. Harris extends the comparison of land valuation techniques and the methodology used in the valuation of shares and financial assets by expressing the capitalisation rate as a function of the required rates of return on debt and equity.

$$d = w_d d_d + w_e d_e \qquad (3.4)$$

Where d_d and d_e represent the nominal required rates of return on debt and equity and w_d and w_e are the proportion of the portfolio financed by debt or equity. Taking inflation into account the above may be rewritten as

$$d = w_d (r_d + \Theta_d) + w_e (r_e + \Theta_e) \qquad (3.5)$$

where r_d and r_e represent real rates of return and Θ_d and Θ_e represent inflation premiums on debt and equity respectively. If the holders of debt and equity have the same inflationary expectations ($\Theta_e = \Theta_d = \Theta$) then the equation may be simplified to

$$d = w_d r_d + w_e r_e + \Theta \qquad (3.6)$$

and the model can be rewritten as

$$V_o = \frac{R_o (1 + g)}{w_d r_d + w_e r_e + \Theta - g} \qquad (3.7)$$

Harris states that this model is far more explicit in its identification of factors affecting values than the Melichar model.

Following a review of the trends in the ratio of cash rents to value data for several selected regions of the United States, Reinsel and Reinsel (1979) propose that earnings expectations among land buyers have changed over time. Several possible causes are suggested, one of which was the movements of population caused by birth, death and net immigration. This is, in essence, a variation on the Ricardian argument. Reinsel and Reinsel also note that marketing more United States agricultural products overseas has a similar effect to a domestic population increase. Farm programs also act to stabilise incomes and thereby alter expectations of future earnings. An implication of continuously rising land prices was seen to be "current land owners benefiting from wealth changes at the expense of future generations of farmers" (p 1097).

Doll and Widdows (1981) suggest that the constant growth valuation model provided a view of land price determination that is too restrictive. They state that investors may be annually reformulating expectations of growth rates as well as the value of initial earnings and that this has led to rapid growth rates in asset values as evidenced in the seventies. They go on to state that the more general model, as outlined by Harris (1979), and in equation (3.3) would provide solutions "richer in interpretation". More importantly, they stress the importance of approximating or modeling the manner in which investors formulate expectations concerning the variables in the model.

In summary much of the recent literature and discussion on land prices has featured the Melichar hypothesis. The debate over whether or not land behaves as a growth stock has revolved around the assumption that the growth rate in equation (3.2), g, is the growth rate of <u>both</u> the value of the land <u>and</u> the earnings of that land. This is the critical assumption, - that land values and earnings will grow at the <u>same</u> compound rate, g, <u>forever</u>. The model assumes that the total yield is comprised of two parts - a capital gain component and an income yield component and that economic agents are indifferent between either.

What are the implications of these assumptions? If a simple bivariate model is formulated in which land price is regressed on expected income then we obtain the following specification

$$LP_t = B_0 + B_1 R^*_t + u_t \qquad (3.8)$$

where R^*_t is expected real income, LP_t is the real value of the land and u_t is an error term distributed with the usual Gauss Markov assumptions. It can be seen that the parameter B_1 is in fact the inverse of the denominator of equation (3.2), i.e. $1/(d-g)$. By taking the inverse of this parameter and adding back g we obtain what can be described as the investors' required rate of return. This may also be defined as the cost of equity capital, (Van Horn, 1977, p 216). In equilibrium, this rate may be compared with investments of a similar class of systematic risk.

Therefore, if the constant growth model is indeed the true model the impact of capital gains has already been included in the specification and there is no need to include it as an explanatory variable. If however, the growth rate of income and the growth rate of land prices are not equal then the critical assumption of the model is violated.

3.2 Asset Appreciation and Capital Gains

Castle and Hoch (1982) state that recent increases in farm real estate prices cannot be explained on the basis of earnings in agricultural production alone. This view contradicts the Melichar hypothesis that increases in land value can be explained by increases in rents.

Capital gains in both the United States and New Zealand have been very large. Bhatia (1971) estimated that between 1947 and 1968 real capital gains on farm real estate in the United States amounted to US$87.89 billion. Leathers and Gough (1984) reported that in New Zealand, nominal capital gains on farm real estate fluctuated between NZ$0.5 billion and NZ$1.5 billion per year, but this estimate may be quite conservative given the estimates in Table 2.2. Melichar (1979) stated that in the United States annual increases in asset values had exceeded annual income, often by wide margins.

Plaxico (1979) states that capital gains impact on the aggregate consumption function and affect investment and production decisions, therefore they cannot be ignored when assessing economic welfare and the price of the asset concerned (p 1099). Bhatia (1972) proposed that capital gains could enter the aggregate consumption function through either an income or wealth effect.

Plaxico and Kletke (1979) examined the valuation of accrued capital gains in a "stream of income" approach and demonstrated that capital gains do not have to be realised to be spent. Increases in equity in land in any given year are available as a financial reserve or as an equity base for expansion. Equity increases may be viewed as improving financial ratios (particularly leverage) and/or increasing financial flexibility (p 327).

Castle and Hoch (1982) suggest that capitalised rent explains only about half of the variation in United States real estate values over the period 1920-1978 and proposed that the remainder could be explained by the capitalisation of capital gains including real gains or losses from changes in the general price level. The prospective investor in farm real estate forms an expectation of next year's price. If the expected price exceeds the current price the investor will wish to buy real estate. In contrast if current prices exceed expected prices, the investor will wish to sell his or her real estate holdings.

The expected price of real estate is hypothesised to have two major components and an important subsidiary component. The first component (V_1) is the present value of the future earnings to land, measured by the capitalised value of the net rent from the land. The second component or real capital gains component (V_2) is determined by all the "forces" that cause real growth in the value of land. The third component (V_3) is a subcategory of (V_2) and is called the price level component. This arises because as long as market interest rates do not fully account for inflation, borrowers are better off and lenders are worse off when the general price level increases. High and increasing levels of the capitalised value of capital gains arising from factors specific to the agricultural sector plus the capitalised value of gains and losses from changes in the real value of debt, have combined to make agricultural real estate an appealing investment compared to other investments of comparable risk.

Bergland and Randall (1984) used models based on asset pricing theory to demonstrate the determination of farm land prices, the possibility of above normal returns to land ownership and what they termed "one shot" capital gains. They state that while virtually any positive change in expectations can bring about a "one-shot" increase in land prices, smoothly rising <u>real</u> land prices can only be caused by smoothly rising real land rents.

3.3 Inflation and Feldsteins Portfolio Demand Model

Feldstein, (1980a) (1980b) developed a model of portfolio equilibrium that not only dealt with factors that influenced the price of land but also the impact of these factors on other assets that may be part of the investors portfolio. Feldstein has argued that the effect of inflation on asset prices will not be neutral. Because of the structure of the United States tax system inflation should increase the real price of land and other assets such as gold. Martin and Heady (1982) and Alston (1985) state that the point of Feldstein's work was that the basic neutrality of taxes and inflation breaks down when their simultaneous effects are considered. This is the opposite side of the discussion of how inflation depresses the price of ordinary shares (Feldstein 1980a). The combination of favourable tax laws and inflation are hypothesised to interact to raise the return on land and lower the return on reproducible capital (shares). For investors to be willing to hold assets in the original quantities the prices of the assets must adjust to the new inflationary expectations. The price of land will therefore rise and the price of reproducible capital will fall. Essentially the portfolio equilibrium model is based on a simple arbitrage assumption.

Martin and Heady (1982) have summarised the conditions of the Feldstein argument as follows. In a stationary economy with an inflation rate, π, there are:

(a) Land and physical assets, (L) which have two returns. Firstly, a real net income per unit (R) and secondly an inflationary increase in value at a rate π.

(b) Debentures and other money deposits (B) which have one return (R) equal to the nominal rate of interest. This return includes an expectation of inflation (π) and a real interest rate component r.

(c) Shares (K) that yield both a dividend d and capital appreciation at rate π. This is also referred to as reproducible capital.

Feldstein's economy consists of identical individuals, therefore the tax rates applicable to each individual are also identical. It is assumed that the current inflation rate is known but the rate of inflation in the future is unknown. Initial stocks of land and capital are assumed fixed. Feldstein acknowledged the short-comings of such an assumption, however, his focus was on the portfolio choice aspect rather than on the dynamic general equilibrium response.

Feldstein first developed price equations for each asset. At the start of the "Hicksian week" there are initial holdings of L units of land, K units of capital (or common shares) and B_1 dollars of debentures or Treasury Bills as they are referred to in an earlier paper, Feldstein (1980a). The initial holdings reflect a previous set of expectations about asset yields and risk. At the start of the week another set of expectations will be formulated. These expectations infer that a set of asset prices also exist. Say P_L for land and P_K for shares. Therefore the individuals initial endowment is:

$$\bar{B}_1 + P_L \bar{L}_1 + P_K \bar{K}_1$$

Feldstein (1980b) then derives the price equation for land such that;

$$P_L = (1-T_y)R/[(1-T_y)r - (1-T_c)\pi + c'(\sigma_{LL}L + \sigma_{LK}K)] \qquad (3.9)$$

If we denote $c = c'(\sigma_{LL}L + \sigma_{LK}K)$

then, $LP = (1-T_y) R / [(1-T_y)r - (1-T_c)\pi + c]$

where LP = the price of land divided by the price level, i.e. the real price of land

T_y = income tax rate

T_c = capital gains tax

π = the inflation rate

R = expected return per unit of land

c = risk aversion factor

r = nominal interest rate

σ_{LL} = variance of land

σ_{LK} = covariance of land and capital

L = initial endowment of land

K = initial endowment of capital

This may be rearranged as

$$LP = \frac{R}{r - [(1-T_c)/(1-T_y)]\pi + c/(1-T_y)} \qquad (3.10)$$

If there is no risk and/or inflation then c and π both equal zero. The real price of land is then the discounted value of the expected return per unit of land, i.e. LP = R/r. If there is inflation but no risk then,

$$LP = R/[\ r - (1 - T_c)/(1 - T_y)\ \pi]$$

Because the rate of capital gains tax T_c is usually less than the income tax rate T_y then

$$(1 - T_c)/(1 - T_y) > 1$$

Feldstein points out that the "net discount rate"

$$[r - \pi(1 - T_c)/(1 - T_y)]$$

can easily become negative. That is, as π rises the term

$$r - \pi(1 - T_c)/(1 - T_y)$$

approaches and passes through zero and becomes negative. This implies that the real price of land would become indefinitely large, eventually infinite and then negative. Feldstein suggests that recognising the role of uncertainty and risk aversion in the determination of the real price of land is very important. In the equation 3.10 risk aversion can eliminate these "anomalous" results. By including c in the denominator, relative asset prices are not nearly so sensitive to differences in the mean real rates of return. In effect c dampens the response of the real price of land to changes in predetermined variables.

When the rate of tax on capital gains, T_c, is less than the tax on other income, T_y, an increase in the steady rate of inflation or the rate of income tax will cause an increase in the real price of land. An increase in either the rate of capital gains tax T_c the risk premium, c, or the nominal interest rate, r, will cause a decrease in land prices.

These results are summarised in the following table.

TABLE 3.1

<u>Summary of the Effects of Predetermined Variables on the Price of Land</u>

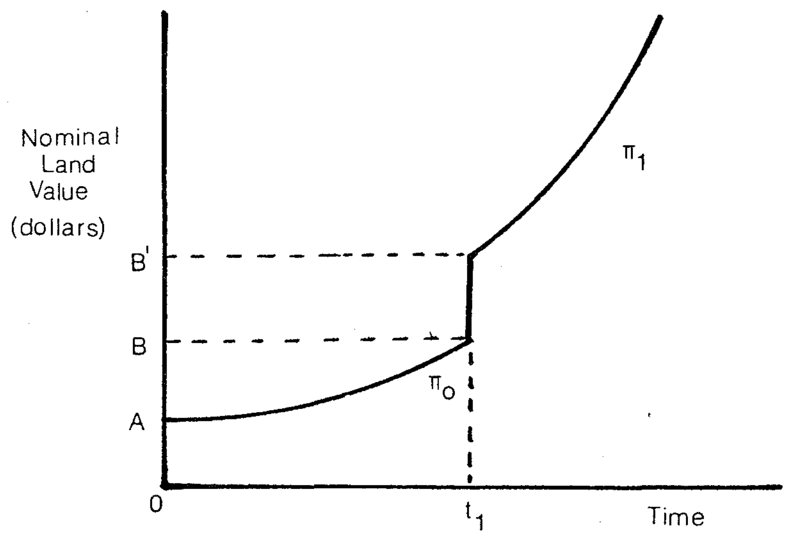
Increase in the predetermined variable	Decrease in Farmland Price	Increase in Farmland Price
π		*
T_y		*
T_c	*	
c	*	
r	*	

π = Inflation rate
T_y = Income tax rate
T_c = Capital Gains Tax
c = Risk aversion factor
r = Nominal interest rate

It is important to note that in both the Melichar and Feldstein hypotheses, sustained real growth in land prices will require a sustained increase (or decrease) in some component(s) of the equation (Alston, 1985).

The nature of the effect of an increase in the rate of inflation on land price is described by Martin and Heady (1982). An increase in the inflation rate leads to a one off increase in land value. After this initial "jump" the price of land increases at the same rate as the general rate of inflation, see figure 3.1. Prior to t, land increases at a rate π_0. After t_1 land increases in value at an increased rate π_1. However, there has been a one off increase in land value from B to B'.

FIGURE 3.1
<u>Effect of an Unanticipated Increase in the Inflation Rate on Land Prices</u>



Source : Martin and Heady (1982)

Feldstein (1980b) therefore suggests that the continuous increase in the price of land during the 1970s in the United States may in fact be considered to be a combination of two factors. Firstly, small changes in the equilibrium real price of land as expectations of the inflation rate change. Secondly a continual increase in the nominal price of land at a rate π_1.

Martin and Heady describe Feldstein's hypothesis as "intuitively appealing" when one examines the movements in land prices in the United States over the 1960's and 1970's. In the New Zealand context the relationship also seems to have some plausibility. However, Martin and Heady raise two cautionary points. Even if one accepts that the theoretical price model is correct its implications may be irrelevant to the farm real estate market if:

(i) The farm real estate market and the share and secondary security markets are not adequately interrelated. If this is the case, the portfolio adjustment process may not occur to the extent that is hypothesised.

(ii) Imperfect information means that individual investors have an inadequate knowledge of future inflation and tax rates.

Martin and Heady attempted to empirically test the Feldstein hypothesis by formulating a number of single equation models of the farm land market. They noted that in Feldstein's model of portfolio equilibrium, the exogenous variables were: the expected rate of inflation, net returns from each asset, the variability in each category of net returns, the expected growth rate of net returns, the structure of the tax system and the real interest rate. The price of each asset is endogenous and the complete model can be viewed as a simultaneous system.

They concentrated upon reduced form equations that included the rate of inflation as an explanatory variable, as well as net returns, the variability of net returns and the expected growth rates of net returns. Expectations of inflation were hypothesised to be formed adaptively and by interest rate based expectations measures. Adaptive expectations formulations suggested a negative impact of inflation on farm land prices. On the other hand interest rate based expectation measures had positive coefficients.

Feldstein assumed that nominal interest rates increased in direct proportion to the inflation rate. That is, the real rate of interest was unaffected by the rate of inflation. This assumption is central to the formulation of rational, interest rate based, expectations of future inflation. That is, the use of interest rates is consistent with the rational expectations hypothesis that market participants form expectations of inflation which are unbiased estimates of the true value, given the information available.

Feldstein (1980b) states that the real, net of tax, rate of return may be expressed as $i = (1-T_y)\ r - \pi$ where i is a real rate of interest and r is the nominal interest rate and π the rate of inflation.

Because the tax is levied on the nominal return, the real net of tax returns will vary with the rate of inflation. Alston (1985) refers to this as the Darby hypothesis. That is, the after tax real interest rate (i) is unaffected by the inflation rate. The so called Fisher equation is; $r = i + \pi$ or $i = r - \pi$. This formulation implies that nominal interest rates are not affected by income taxes.

Alston also states that the question of which interest rate hypothesis is appropriate is really an empirical matter. Alston formulated an empirical model that was based on Feldstein's price equation for land as described in equation (3.10). Alston's model is a synthesis of the Melichar and Feldstein hypotheses and the regression analysis employed a modified version of (3.10) which incorporated expected capital gains in the numerator as a component of income. Alston considered this model to be "theoretically identical" but "intuitively more straight forward and analytically more convenient" (p 13). The model is as follows:

$$LP_t = [R_t + \Delta LP*_t\ (1-T_c)/(1-T_y)]/D_T' \qquad (3.11)$$

where $D_t' = c_t/(1-T_y) + r_t - \pi*_t\ (1-T_c)/(1-T_y)$,

$\Delta LP*_t$ = expected real capital gains in year t,

$\pi*_t$ = expected inflation in year t,

and all other variables as defined previously.

Alston found that the inflation effect on land prices was significantly negative but empirically relatively small. It was suggested that this may have been due to the Darby effect or alternatively to the effects of inflation on the risk premium. In either case the result was contradictory to what the Feldstein hypothesis would suggest.

Both Martin and Heady and Alston empirically rejected the Feldstein hypothesis that increases in real land prices could be explained by increases in the inflation rate. Alston concluded that inflation had "little, if any, effect on real land price growth ... in contrast to Folklore and Feldstein". In both studies inflation was in fact found to have a slight negative effect. The work by Martin and Heady and Alston tends to reinforce the Melichar hypothesis, that growth in land prices is best explained by growth in net rentals.

3.4 Debt and Consumptive Demand

As well as the central theories of Melichar, Feldstein, and the other researchers whose work has been discussed in the preceding sections, other determinants of farm land prices have also been hypothesised.

With the help of a model based on a theory of life-cycle utility maximisation, Shalit and Schmitz examine the effect of the allocation of debt on farm land prices. They propose that land purchases are made to increase profits and provide leverage for further land expansion (p 710). The derived demand for farm land generated by agricultural production is the focus of their alternative theory of land price determination.

They state in their conclusions that savings, or the difference between farm income and consumption, are the main determinants of high farm land prices. They also demonstrate that farm land values are not determined solely by the profit that is generated by either agricultural income or by capital gains, but rather by the debt that the property can carry. They therefore propose that the sources of credit serve to determine farm land prices.

Burt (1985) points out that credit rationing in the Shalit and Schmitz model is the factor that makes debt so important and that although the model "should not be taken too seriously as a description of the farm land market" it does provide some insight into the economic forces involved. Also, one of the serious problems with the model is that it is deterministic and as such "yields a model hardly appropriate for empirical testing".

Hughs, Penson and Bednarz (1984) (HPB) also examined the impact of credit policies on farm land values. They concentrated upon the effects of the credit policies of government agencies. To examine this aspect they developed a theoretical model of the farm land market which they then used to simulate the effects of a number of credit policies. HPB state that although farmers use land as an input to production, land also enters the utility functions of non farmers and non-operator landlords for either residential (consumptive) uses or as an investment alternative (speculative use).

A seven equation model of the land market is developed that captures farm operators' demand for land as well as that of the non operator landlords. They then attempt to account for the derived demand for farm land by the farm business and the farm family's investment demand in a portfolio balancing framework.

HPB conclude from their model that government sponsored farm credit programs have probably increased farm values, farmer's holdings of financial assets and farm debt.

The preceding papers have included references to farmers' utility functions and the proposition that farmers maximise utility as opposed to profit. Pope and Goodwin (1984) share this hypothesis and state that land is not only an input into agricultural production but is also an important argument in many individuals utility functions. That is, land has a consumptive use as well as a productive use and speculative use.

3.5 Summary

The discussion in the literature concerning net farm income as a determinant of land price is characterised by the Melichar hypothesis. Melichar (1979) and (1983) proposed that the value of farm land could be explained by the use of a constant growth valuation model. This involved the assumption that the growth in the asset value and the growth in income were equal and constant into perpetuity. The validity of this assumption has been questioned by Doll and Widdows (1981). However, Melichar holds strongly to his contention that increases in the price of farm land can be explained by increases in farm income as he defines it.

On the other hand, Castle and Hoch (1982) state that capitalised rents explain only about half of the variation in United States land values over the period 1920-1978. They propose that land values have two major components. Firstly, the present value of future earnings to land, and secondly, the value of capital gains to farm purchasers which include the effect of inflation on market interest rates and in turn the real value of debt. Plaxico and Kletke (1979) also suggest that capital gains and expectations of wealth play an important role in the formulation of farm land values. Plaxico and Kletke extended the analysis conducted by Bhatia (1972) in which the significance of wealth accumulation was examined. The conclusion was that capital gains did not have to be realised for farm land owners to derive utility from them.

An important assumption of the Melichar hypothesis is that the growth rates of both income and asset values are equal. If this is the case then the constant growth model is an appropriate model of farm land price determination. The value of the asset (land) will reflect the level of income, both of which are growing at a constant rate into perpetuity. If however, land values and incomes do not grow at the same rate, the level of income in isolation, will not provide an adequate explanation of the price of the asset. For this reason it may be more appropriate to include the assumption that capital gains also have some effect on the value of farm land.

Feldstein (1980a) and (1980b) used a model of portfolio equilibrium to provide an explanation for the divergence between farm land value and farm income. Feldstein (1980a) argues that the effect of inflation on asset prices will not be neutral. The structure of the United States tax system combined with a general price inflation implied that in a portfolio equilibrium model, the price of land would increase proportionately more than changes in the price of other assets. In a later article Feldstein (1980b) included uncertainty in the model. This served to decrease the magnitude, however it did not change the direction of the effect. The Feldstein hypothesis has been empirically tested by Martin and Heady (1982) and Alston (1985). Both studies rejected Feldstein's maintained hypothesis that increases in real land prices could be explained by increases in the inflation rate.

In a study by Shalit and Schmitz (1984) the importance of credit rationing was recognised as a factor influencing land price. Their model is based on a complicated theory of life-cycle utility maximisation. The results of their study suggested that an individual's desire to purchase land increased with land prices because the extra equity provided loan collateral. Burt (1985) empirically tested the significance of debt as a determinant of farm land prices by including debt as an explanatory variable in a model. The results indicated that the variable as defined was not statistically significant and also had an "illogical sign".

Hughs, Penson and Bednarz (HPB) (1984) also examined the impact of debt on farm land values. However, they specifically examined the effect of government sponsored credit programs on farm land prices with the aid of a seven equation simultaneous equation model of the aggregate farm land market. They concluded that government sponsored programs have increased not only farm values, but also farmers' holdings of financial assets and farm debt.

The next chapter will deal with the specification of three models which include the theory that has been discussed in this review. Briefly, the models will incorporate the two major hypotheses, that is, the Melichar and Feldstein hypotheses, and also the theory relating to capital gains. These three topics are being examined as it is considered a priori that in the farmland market they are the most important determinants of land prices.

CHAPTER 4

MODEL SPECIFICATION

Three broad themes emerged in the literature reviewed in Chapter 3. The first, the Melichar hypothesis, was that land prices were determined primarily by the expected level of rents that could be earned from that land and that any other factors were insignificant as determinants of land prices. The second theme was a corrollary to the first. Variations in the level of expected rents explain a large part of the variation in land prices, however, they do not explain all of the variation. Expected capital gains were proposed to be the factor that explained the balance of the fluctuations. Lastly, land was proposed to be part of a rational investors portfolio. Feldstein (1980a) proposed a portfolio demand model, incorporating the effects of inflation in which the price of land was jointly determined with the prices of other assets. Due to the interaction of inflation and the favourable taxation treatment of capital gains in the United States, the real price of land increases more than the price of other assets.

In order to examine these three broad theories it is first necessary to specify models which incorporate these themes. Model one is a simple bivariate model that incorporates an expectations process, defining real farm land price as a function of real expected net rental income. Model two defines real farm land prices as a function of two explanatory variables, both of which are "expected" variables. The real price of farm land is defined to be a function of expected real net rental income and also expected real capital gains. Model three is similar to model two, however real farm land prices are postulated to be a function of expected real net rental income and expected inflation.

4.1 Model One - A Simple Model of Land Prices

Melichar (1979) and (1983) hypothesises that land prices are determined in general by net rents. The value of land is therefore a function of expected net rentals as the growth rates of both land and net rental income are implicitly assumed to be constant and equal into perpetuity. This may be expressed in a model, following Martin and Heady (1982) and Alston (1985), as

$$LP_t = B_0 + B_1 R^*_t + u_t \qquad (4.1)$$

Where LP_t = the value of land in period t
$R*_t$ = the expected value of net rental income in period t
u_t = the disturbance term N.I.D. $(0, \sigma_u^2)$.
and B_o = the intercept term

4.2 Model Two - Incorporating Capital Gains into the Model

Castle and Hoch (1982) and Plaxico and Kletke (1979) hypothesise that capital gains as well as rents have a hand in determining land prices. In the New Zealand case can it be said that the growth rates of rental income and land price are equal? By taking logs and then taking first differences, the percentage change in land prices may be regressed on the percentage change in rental income. If the two rates were closely related the parameter value b_1 would not be statistically significantly different from unity, Alston (1985). That is, a one percent change in the explanatory variable, the growth rate in rental income, would lead to a one percent change in the dependent variable, the growth rate in land prices.

Thus,

$$d\ln LP_t = b_1 d\ln R_t + u_t \qquad (4.2)$$

where $d\ln LP_t$ is the percent change in the price of land,
and $d\ln R_t$ is the percent change in the rental income to land.

If the parameter b_1 is statistically, significantly different from unity then it may be suggested that the two growth rates are not equal and that the constant growth model is inappropriate. If this were the case, it would mean that not all of the variation in land prices could be explained by net rental income. Castle and Hoch (1982) proposed that expectations of capital gains were also significant determinants of farm land prices. Therefore a model including this development could be specified as

$$LP_t = B_o + B_1 R*_t + B_2 Cg*_t + u_t \qquad (4.3)$$

where $Cg*_t$ = the value of expected capital gains and all other variables are defined as before. This model states that land prices are a function of expected net rental income and expected capital gains.

4.3 Model Three - Introducing the Feldstein Hypothesis

Feldstein (1980a) and (1980b) proposed that the effect of a general price inflation was to cause the real price of land to increase. The portfolio equilibrium model revolves around a simple arbitrage assumption and also the assumption that the rate of capital gains tax on land is less than the rate of income tax.

The continuous rise in nominal land prices in the United States was considered by Feldstein to be a combination of two factors. Firstly, small changes in the equilibrium real price of land brought about by expectations of changes in the general price level (the rate of inflation). The second factor is a continual increase in the nominal price of land (Feldstein, 1980b; pp 910). The statement of these two factors would suggest that if real land prices were specified as a function of real net rental income and inflation then some evidence may be obtained concerning the veracity or otherwise of Feldstein's hypothesis in the New Zealand context.

Empirical studies performed in the United States by Martin and Heady (1982) and Alston (1985) have found that if anything, inflation has had a slight negative effect on real land prices. The object of this part of the study is to see if this is the case in the New Zealand pastoral sheep and beef sector. As discussed by Martin and Heady (1982 p.30) expectations of inflation may be introduced by formulating the equation as:

$$LP_t = B_o + B_1 R*_t + B_2 P*_t + u_t \qquad (4.4)$$

where

$R*_t$ = expected real net rental income

$P*_t$ = expected inflation rate

Expectations are postulated to be formed adaptively. Thus, equation 4.4 defines land prices as a function of expected net rental income and expected inflation.

Before discussing these competing models further, we will briefly outline "expectations" and several theories of their formulation.

4.4 The Treatment of Expectations

The models (4.1), (4.3) and (4.4) are examples of equations where the value of the dependent variable does not depend upon the actual value of the explanatory variable but rather upon the "expected" or "permanent" level of that variable, Koutsoyiannis (1977). A model is specified in this way so that it may firstly account for expectations about future factors and secondly because it may be theoretically implausible in some circumstances to assume that, for example, the optimal level of farm land prices depend upon the current and only the current values of say, net rental income.

As they stand, equations (4.1) and (4.3) and (4.4) are non-operational because R^*_t and Cg^*_t and P^*_t are unobservable variables. Therefore, the equations are augmented with assumptions about how expectations are formed. Turnovsky (1972) and Carter and Maddock (1984) have discussed several methods by which expectations may be formed. Four general schemes, which are discussed briefly below, are static expectations, extrapolative expectations, adaptive expectations and rational expectations.

<u>Static</u> expectations stem from the simple hypothesis that expectations of the future value of an explanatory variable are based on the current value of that explanatory variable. To make the model operational the determination of the expected value of the explanatory variable must be specified in terms of observable variables. This is termed closing the model, Carter and Maddock (1984). Therefore the behavioural equation that closes the model states that economic agents form their expectations of net rental income next period based on the current periods level of net rental income.

Thus, the behavioural equation is:

$$R^*_t = R_{t-1} \qquad (4.5)$$

and therefore

$$LP_t = B_0 + B_1 R_{t-1} + u_t$$

<u>Extrapolative</u> expectations are based not only on the past level of an economic variable but also on the direction of change. This is an attempt to overcome the naivety of static expectations.

The behavioural equation is redefined as

$$R^*_t = R_{t-1} + \Theta (R_{t-1} - R_{t-2}) \qquad (4.6)$$

where Θ is the coefficient of expectation.

The extrapolative expectation in any period is equal to the level of net rental income last period plus a fraction, Θ , of the change between the previous two periods. If Θ is greater than zero, past trends are expected to continue. If Θ is less than zero, past trends are expected to be reversed, and if Θ equals zero extrapolative expectations are identical to naive static expectations.

Adaptive expectations, initially devised by Cagan (1956), have been used by Martin and Heady (1982) in examining inflationary expectations and the price of land. Agents are hypothesised to revise their expectations each period according to the degree of error in their previous expectations. Thus, the expectations of the level of net rental income in period t are defined as:

$$R^*_t = R^*_{t-1} + (1-\lambda)\ (R_t - R^*_{t-1}) \qquad (4.7)$$

where λ is the coefficient of adaptation. This coefficient determines the speed that economic agent's expectations adjust to past errors. The behavioural relationship states that current expectations are formed by modifying previous expectations in the light of actual experience. By performing a transformation to eliminate the unobservable variable R^*_t the estimable form of the equation is obtained. The result of the transformation is statistically indistinguishable from the Koyck Transformation which is performed to remove the infinite distributed lag. This expectations process will be discussed further in Chapter 5.

The rational expectations hypothesis was first advanced by Muth (1961). According to Carter and Maddock the three hypotheses discussed above have a common failing. That is, they are not based on any underlying theory of economic behaviour but rather, are completely arbitrary. Muth, on the other hand proposed that utility maximising economic agents would use all the information available to them in forming their expectations. Muth concluded that a knowledge of the structure of the economic system would be used by economic agents in forming expectations. Carter and Maddock state that the innovation introduced by Muth was to consider the expected value of the variable to be endogenous to the model. The agents in the economic system - buyers of farm land - are assumed to know the structure of the model and use this information to form their expectations. Therefore the additional behavioural equation that incorporates the hypothesis is:

$$R^*_t = E_{t-1}\ [R_t] \qquad (4.8)$$

where E_{t-1} [ ] is an expectation operator conditional upon information available in period t-1. Therefore the expected value of net rental income in any period is equal to the "equilibrium value" of the explanatory variable plus the expected value of the error term u_t. The expected value of the error term will depend upon the stochastic properties of the error term. An error term with the usual Gauss Markov properties will have an expected value of zero. On the other hand, a serially correlated error term, where

$$E[u_t\ u_{t-1}] \neq 0,$$

will mean that past history has some impact upon the determination of future values. Therefore when the disturbance terms are autocorrelated, information is available to the decision maker in period t-1 and this in turn will be used in forming expectations. Although rational expectations and adaptive expectations are related, rational expectations have the advantage that they provide a basis for calculating the weights used in the distributed lag process. On the negative side however, truly rational expectations require a large amount of information and for this reason "weakly" rational expectations are often used.

4.5 Definition of the Variables

In the models defined in the previous sections, land prices were defined as functions of expected net rental income, expected capital gains and the expected inflation rate. Unfortunately time series data on net rents in New Zealand are not readily available. The alternative is to calculate proxies for land price and net rental income which will capture the effects of the unobtainable variables and maintain the relationship between the price of land and its explanatory variables. This approach has been criticised by Alston (1985) as being prone to computational errors and for being an ex-post measure. Alston used survey data of what respondents would expect rents in their county to be. However, as much as one would like net rental data for sheep and beef farms in New Zealand, none is available. The approach taken in this study is to adjust land price and net income to obtain two theoretically comparable series. This technique is used by the Meat and Wool Board Economic Service (MWBES) and the United States Department of Agriculture (USDA). The data used in this study for the computation of all variables originated from either work by the MWBES, Laing and Zwart (1983) or the Department of Statistics. The period of the study is 1962 to 1983. The sector chosen for the study was the MWBES "All Classes Average" classification of meat and wool farms in New Zealand.

4.5.1 Proxy for Land Value - Total Production Assets $ per hectare - LP_t

This variable is defined as the capital value of the property less the value of the dwelling, plus livestock, machinery, vehicles and other farming assets, plus working capital. The reason for adding the value of all of the other assets into the "Land" value is that it is virtually impossible to extract a return that is purely the return to land or land rent. The rental that is actually calculated, i.e. the current returns to assets, is the rental attributable to all farming assets except labour and management, and not just land. The real value of this variable is obtained by deflating the land value component by the Land Price Index and the other components by the Prices Paid Index (see below).

4.5.2 Proxy for Net Rental Income - Current Returns to Assets - $ per hectare - R_t

This variable measures the net income produced by farm assets regardless of their method of financing or ownership. Rent and interest are added back to the value of net farm income. This is the return to production assets, management and labour. To obtain the return to production assets, the returns to management and labour are also imputed and deducted. The residual is the return attributable to production assets. This variable is converted into real terms by deflating by the Prices Received Index.

4.5.3 Capital Gains - $ per hectare - Cg_t

As defined by Bhatia (1971), nominal capital gains were calculated as the first differences of Total Production Assets less an adjustment for net investment in the farming enterprise. That is

$$NCg_t = NLP_t - NLP_{t-1} - N_t$$

where NCg_t = nominal capital gains in period t.

NLP_t = the nominal value of Total Production Asset in period t

N_t = the value of Net Investment in sheep and beef farms in period t.

A series for Net Investment in sheep and beef farming was obtained from work by Laing and Zwart (1983). Real capital gains were also calculated using a definition provided by Bhatia (1971).

That is,

$$Cg_t = NLP_t - NLP_{t-1} \frac{(I_t)}{(I_{t-1})} - N_t$$

where

Cg_t = Real Capital Gains in period t

I_t = price index

and all other variables are as previously stated.

4.5.4 Proxy for the Inflation Rate, Percent - P_t

In this study the percentage change in the consumer price index has been chosen as a measure of the overall inflation rate in the general economy. It was chosen because it was considered to be the index most consistent with Feldstein's (1980b) discussion and hypothesis.

4.5.5 Indices Used in this Study

Several indices have been used in this study to convert nominal time series to real time series. Although other studies have not used specific indices it was considered more appropriate for the index, which was used to deflate a particular series, to be closely related to that series. For example, nominal land prices have been converted to real land prices by using the land price index (LPI) for fattening and grazing land. As well, other farm assets have been deflated by the prices paid index (PPI) for farm inputs. Similarly, farm income has been deflated by the prices received index (PRI).

Few overseas studies have deflated individual variables by the most closely related index. For example, Doll and Widdows (1982d) used the Consumer Price Index (CPI) to convert nominal time series data to real. They considered that this was a far more comprehensive indicator of the purchasing power of funds for farmers general consumption requirements than an index that only considered specific items such as the farm inputs index. Melichar (1979) and (1983) used the Implicit Price deflator for personal consumption expenditures (PCE) as he considered that the CPI had fixed weights and as such overstated the rate of inflation faced by households when interest rates were rising. Martin and Heady (1982) and Alston (1985) used the Gross National Product (GNP) deflator. Martin and Heady also used the percentage change in this deflator as a proxy for general price inflation in some equations.

4.5.6 Potential Biases and Problems with the Data

The MWBES data is recorded in such a way that capital expenditure cannot be easily disaggregated from general expenditure. It is possible that expenditure that would otherwise be classified as investment could be included in say repairs and maintenance. This would mean that the proxy for net rental income would be biased downwards, while the proxy for land price would be biased upward. To some extent the adjustment that is made for net investment in the capital gains variable does account for this, however, the bias is still present.

In financial years with high product prices and high gross incomes, farmers may increase expenditure on items such as fencing materials or chemicals in an effort to reduce taxable income. The items that are purchased will not be used in that year and may well be used over the following several years. This form of investment tends to blur the link between the proxies for net rental income and land price, and although expectations of income are high, the actual recorded income may be low.

CHAPTER 5

A BIVARIATE MODEL OF LAND PRICE DETERMINATION

In Chapter 4, a simple bivariate model was specified which embodied what has been referred to as the Melichar hypothesis. That is, movements in land prices may be almost entirely explained by changes in expected net rents. In this chapter, following Martin and Heady, adaptive expectations will be incorporated into model one so as to make it operational. A fuller description of the approach is contained in Seed (1986).

5.1 Applying the Adaptive Expectations Hypothesis

The adaptive expectations process is based on the notion that economic agents revise their expectations of the value of an explanatory variable in each period according to the error in their previous expectations. The simple bivariate model (4.1), where land price is a function of expected net rents, may be written as

$$LP_t = B_0 + B_1 R*_t + u_t \qquad (5.1)$$

The behavioural equation which describes the manner in which the expectations are formulated is

$$R*_t - R*_{t-1} = (1-\lambda)\ (R_t - R*_{t-1}) \qquad (5.2)$$

$$\text{and} \quad 0 < \lambda < 1$$

By rearranging, equation 5.2 may also be written as:

$$R*_t = (1-\lambda)\ R_t + \lambda\ R*_{t-1} \qquad (5.3)$$

where, $R*_t$ is the expected value of net rental income in period t and λ is the coefficient of expectation. Equations (5.2) and (5.3) demonstrate how net rents $R*_t$ are updated, in each period, by a proportion $(1-\lambda)$ of the difference between the current observed value of the variable and the previous expected value. This may also be written as:

$$R*_t = \frac{(1-\lambda)}{(1-\lambda L)}\ R_t \qquad (5.4)$$

in lag operator notation where the lag operator L, may be defined in general as:

$$L^n X_t = X_{t-n} \qquad (5.4.1)$$

By substituting (5.4) into (5.1) and manipulating, the original equation is made operational:

$$LP_t = B_0(1-\lambda) + B_1 (1-\lambda) R_t + \lambda LP_{t-1} + u_t - \lambda u_{t-1} \quad (5.5)$$

In equation (5.5), the unobservable variable R^*_t has been eliminated. Low values of λ imply that substantial adjustments in expectations occur, while large values of λ imply slowly changing expectations. The adaptive expectations hypothesis relies wholly on past experience and at no time does it "look" forward to the future in the formulation of expectations.

5.2 Estimation Techniques for Model One

Equation (5.5) may be written in general as:

$$LP_t = b_0 + b_1 R_t + b_2 LP_{t-1} + v_t$$

where

$b_0 = (1-\lambda)B_0$

$b_1 = (1-\lambda)B_1$

$b_2 = \lambda$, the coefficient of expectation and

v_t = An error term subject to a number of assumptions

From equation (5.5) it can be seen that the disturbance term is an MA(1) process with the parameter of the process being λ, the coefficient of expectation. If OLS were used to estimate these equations the resulting parameters would be biased, inconsistent and inefficient. As an alternative, other estimation techniques may be used which address the problems of the lagged dependent variable or the autocorrelated disturbance term or both problems simultaneously. These techniques are, Instrumental Variable (IV), Wallis' Three Step technique and the Zellner Geisel grid search technique.

If we assume that the disturbance term is "well behaved" the estimates will be subject to finite sample bias and the OLS estimates will be consistent and asymptotically normally distributed. In this situation, however, the Durbin-Watson statistic is biased toward two. The result would be that the test statistics such as the t scores and R^2 would be biased upward. An alternative unbiased test is Durbin's h test.

Unfortunately, if the error term is serially correlated and as well there is a lagged endogenous variable included as a regressor then the estimates produced by OLS will be biased, inconsistent and inefficient. An estimation technique that attempts to resolve a part of this problem is the IV method.

The IV method reduces the dependence of the disturbance term and the lagged explanatory variable LP_{t-1}. This is achieved by using an appropriate exogenous variable as an instrument for LP_{t-1}. The estimates obtained will be biased for small samples but consistent for large samples because, by assumption, the exogenous variable R_t is uncorrelated, in the probability limit, with the disturbance term. Therefore the technique involves regressing land price on lagged values of the exogenous variable net rental income, to obtain a predicted value $\overline{LP}_t$,

such that

$$\overline{LP}_t = a_0 + a_1 R_{t-1} + a_2 R_{t-2} + \ldots + e_t$$

The number of lagged terms is chosen by using the maximum $\bar{R}^2$ criterion, the conventional R^2 adjusted for degrees of freedom. The term $\overline{LP}_{t-1}$ is then used as an instrument for LP_{t-1}. IV will yield consistent estimates of b_0, b_1 and b_2 since both explanatory variables are uncorrelated in the limit with the disturbance term.

If, however, the disturbance terms are autocorrelated, the estimates will be neither efficient nor consistent. In this case, OLS and IV will both be inappropriate estimation techniques. To produce unbiased, consistent and efficient estimates a technique will be needed that addresses both the autocorrelated error term and the lagged endogenous variable.

Wallis (1967) proposed a three step method for estimating the coefficients of an equation that contains a lagged dependent variable and a serially correlated error term. Wallis summarised the procedure as

1. Estimate the coefficients of the regression
   $LP_t = b_0 + b_1 R_t + b_2 LP_{t-1} + v_t$
   using R_{t-1} as an instrument for LP_{t-1}

2. Calculate the first order serial correlation coefficient ρ from the regression residuals.

3. Using the estimate of ρ compute the matrix Ω^{-1} and calculate the GLS estimates of the coefficients.
   (Wallis 1967: p.565)

Another technique which also aims to take account of the lagged endogenous variable as a regressor and the MA(1) disturbance term is that proposed by Zellner and Geisel (1970). The Zellner-Geisel (Z-G) one way estimation technique <u>simultaneously</u> deals with the lagged endogenous variable and the MA(1) error term, unlike previous techniques which have involved several steps. The Z-G transformation eliminates the lagged endogenous variable from the regressors and also produces a well behaved error term. A transformed data matrix is computed for each value of λ, the coefficient of expectation, and OLS is applied to the transformed variables. The parameter set is chosen that minimises the residual sum of squares.

The Zellner-Geisel two way search technique simultaneously accounts for not only the presence of the lagged dependent variable and an MA(1) error term but also the autocorrelation of the error term of the orginal equation if present. This modified technique may be summarised as:

1. Construct the data matrix variables using alternative values of ρ and λ.

2. Perform OLS on the resulting equation and calculate the residual sum of squares $e'e$ for each pair of values of and ρ.

3. Choose the set of values of λ, ρ, b_o and b_1 that minimise the residual sum of squares.

5.3 Estimation Results for Model One

The estimation techniques outlined in the previous section were used to estimate the model

$$LP_t = b_o + b_1 R_t + b_2 LP_{t-1} + v_t$$

where $b_2 = \lambda$, the coefficient of expectation and

$$b_o = B_o (1-\lambda)$$

$$b_1 = B_1 (1-\lambda)$$

and $v_t = u_t - \lambda u_{t-1}$

Table 5.1 summarises the results of estimating the adaptive expectations model using several alternative estimation techniques and these results are discussed in the following sections.

TABLE 5.1

Estimation Results for Alternative Estimators of the Model One

1. Ordinary Least Squares

$\hat{LP}_t = 0.359 + 4.602\ R_t + 0.600\ LP_{t-1}$
(2.465)** (3.943)*** 1

$R^2 = 0.624$; $\bar{R}^2 = 0.580$; DW = 1.9491
Durbin's h = 0.18
F* = 14.093

2. Instrumental Variables

$\hat{LP}_t = 0.548 + 5.582\ R_t + 0.435\ LP_{t-1}$
(2.215)** (1.357)*

$R^2 = 0.363$; $\bar{R}^2 = 0.268$; DW = 0.808
Durbin's h = undefined (N.Var (B_2) >1)
F* = 4.272

3. Wallis Three Step Technique

$\hat{LP}_t = 0.231 + 4.007\ R_t - 0.120\ LP_{t-1}$
(2.693)*** (-0.596)

$R^2 = 0.322$; $\bar{R}^2 = 0.238$; DW = 1.73
Durbin's h = 1.27 F* = 3.807

4. Zellner Geisel[2] One Way Search RSS minimised when

$\lambda = 0.82$
$\hat{LP}_t = 0.0744 + 4.303\ R_t + 0.997\ \lambda^t$
(2.913)***
$R^2 = 0.529$; $\bar{R}^2 = 0.477$; DW = 1.047
F* = 10.1337

5. Zellner Geisel Two-Way Search RSS minimised when

$\lambda = 0.07$ $\rho = 0.725$
$\hat{LP}_t = 0.3051 + 4.189\ R_t + 6.56\ \lambda^t$
(2.808)***
$R^2 = 0.671$; $\bar{R}^2 = 0.634$; DW = 2.027
F* = 18.344

Notes:

1 t statistics are for H_o: $B_1 = 0$. ( )*** denotes the coefficient is significantly different from zero at the one per cent level of probability of making a Type 1 error. That is, rejecting the null hypothesis when it is true. ( )** denotes the equivalent statistic for the five per cent level and ( )* denotes the statistic for the 10 per cent level of probability.

2 The Zellner-Geisel estimates are reported in their reduced form. The coefficient on λ^* is the "nuisance parameter" that is the result of the Z-G transformation.

5.3.1 Estimation with OLS

With the foregoing assumptions, estimation of an adaptive expectations model by OLS will produce biased and inconsistent estimates and the conventional Durbin-Watson statistic will be biased toward two because of the presence of a lagged dependent variable among the explanatory variables. An alternative test is Durbin h and in this instance the calculated h statistic implied that autocorrelation was absent. This could suggest that the model being estimated was in fact a partial adjustment model as opposed to an adaptive expectations model.

The partial adjustment model has essentially an identical specification to the adaptive expectations model except for the properties of the disturbance term. Whilst the disturbance term of the adaptive expectations model is an MA(1) process, the partial adjustment model has a "well behaved" disturbance term conforming to the usual Guass Markov assumptions. Furthermore if the partial adjustment process is appropriate it suggests that land prices adjust gradually over time toward some desired level, given a change in net rental income. This gradual adjustment is attributable to psychological, technological or institutional inertia, Waud (1986).

The coefficient estimates of B_1 and λ were both statistically significant at the 5 and 1 per cent probability levels respectively. The calculated R^2 and R^2 were 0.624 and 0.580 indicating that the model explains approximately 62 per cent of the variation in farm land prices over the observation period.

The structural parameter, B_1, is calculated as; $B_1 = b_1/(1-\lambda)$, where b_1 is the estimated reduced form coefficient of net rental income and λ is the coefficient of the lagged endogenous variable. These values are reported in Table 5.2.

Table 5.2

Summary of Structural and Reduced Form Parameter Estimates for Model One

Estimation Technique	Coefficient	Reduced Form Estimate	Structural Form Estimate
OLS	b_1	4.602	11.51
		(2.465)**	
	λ	0.600	
		(3.943)***	
Mean lag = 1.5			
IV	b_1	5.582	9.88
		(2.215)**	
	λ	0.434	
		(1.357)*	
Mean lag = 0 77			
Wallis[1] Three Step	b_1	4.007	4.007
		(2.693)***	
	λ	-0.120	
		(-0.596)	
Zellner Geisel One Way Search	b_1	4.303	23.906
		(2.913)***	
	λ	0.82	
Mean lag = 4.56			
Zellner Geisel Two Way	b	4.189	4.504
		(2.808)***	
	λ	0.07	
	$\hat{\rho}$	0.725	
Mean lag = 0.075			

Notes

[1] t statistics are for the null hypothesis Ho : Bi = o

(·) *** denotes that the coefficient is statistically significantly different from zero at the 1 per cent level of probability

(·) ** relates to the 5 per cent and (·)* the 1 per cent levels of statistical significance.

The value of B_1 as calculated was 11.51. The inverse of B_1 equals (d-g) or the denominator of the constant growth dividend model. If 1/d-g = 11.51 then (d-g) = 8.7 per cent. To calculate d, the cost of equity capital to the farming operation, the value of g is required. However, g is the growth rate of the value of the asset and income. For the Melichar hypothesis to be valid the growth rates of the asset value and of income should be roughly equal. This may be tested by regressing: dln LP_t on dln R_t, where dln LP_t is the percentage change in the value of the proxy for real land prices and dln R_t is the percentage change in value of the proxy for real net rental income, Alston (1985). That is,

$$\text{dln } LP_t = b_1 \text{ dln } R_t + u_t$$

The results of this regression are reported in Table 5.3

TABLE 5.3
Testing for the Equivalence of Growth Rates

$$\text{dln } LP_t = \underset{(0.04297)}{0.0969} \text{ dln } R_t$$

$R^2 = 0.2002$ $\bar{R}^2 = 0.2002$

DW = 2.386

( ) = Standard Error

If the growth rates in real land price and real net rental income were approximately equal, the coefficient on dlnR_t would not be significantly different from 1. This hypothesis was rejected. Therefore interpretation of B_1 as the "price earnings" ratio of investment in land becomes rather suspect given the rejection of the hypothesis that the growth rates in real land price and real net rental income are not significantly different.

The value of the coefficient of expectation (λ) was 0.60. The mean lag or average period of readjustment may be calculated as $\lambda/(1-\lambda)$ and in this case was 1.5 periods. This implies that land prices will be reflecting expectations of earnings potential formulated one and a half periods previously.

5.3.2 Estimation with Instrumental Variables

The rationale for using the IV technique is to remove the bias introduced by the presence of a lagged dependent variable among the regressors. To this end, $\overline{LP}_t$ is chosen as the instrument.

The signs of the variables were as expected and the values of the parameters b_1 and λ were statistically significantly different from zero at the five per cent and 10 per cent levels respectively. The Durbin Watson statistic indicated positive autocorrelation and the Durbins h statistic was undefined.

The mean lag, at 0.77, suggests that expectations of net rental income are reformulated at approximately twice the rate of those calculated using the OLS estimate of λ.

5.3.3 Wallis's Three Step Technique

This estimation procedure is a combination of instrumental variables and GLS. The sign of the b_1 coefficient is as expected, however, the sign of λ, the coefficient of expectation is negative and therefore it falls outside the range $0<\lambda<1$. The b_1 coefficient is signficant at the one per cent probability level, but the estimated coefficient on the lagged dependent variable is not statistically significantly different from zero. Thus the reduced form parameter estimate b_1 would be assumed to be equal to the structural form parameter.

5.3.4 Estimation with the Zellner-Geisel Techniques

Estimation of the adaptive expectation model with the Z-G one way search technique produced an estimate of λ of 0.82, similar to the OLS estimate of λ. The sign and magnitude of the coefficient of the independent variable R_* were as expected. However, the value of the structural coefficient B_1 at 23.96 was much larger than any other estimates of B_1. The null hypothesis that all parameter estimates equalled zero was rejected at the one per cent level of statistical significance. A Durbin Watson statistic of 1.020 fell within the "inconclusive" range between the upper and lower limits of the DW statistics. The value of λ of 0.82 indicated that expectations of income changed comparatively slowly, the average period of adjustment being about 4 and a half periods.

The Z-G two way search technique produced estimates of λ and the structural form parameter B_1 that were significantly different from the estimates produced using the one way search. However, the reduced form estimate of the coefficient on net rental income was not significantly different from that estimated using the Z-G one way search. The estimate of λ was 0.07. This suggests that expectations of real net rental income react almost instantaneously to new information. The mean lag in this instance is 0.075 periods. In this study it implies that expectations of net rental income take a little less than one month to be reformulated.

5.3.5 Discussion of the Techniques

From the preceding discussion it may be concluded that the initial assumptions made about the properties of the disturbance term have a large influence on the estimates of λ and in turn, the structural parameter B_1. The assumptions have a lesser effect on the reduced form parameter b_1, as shown in Table 5.2. The estimates of b_1 are fairly insensitive to the estimation technique that is used and range from 4.007 to 5.582. On the other hand, estimates of λ range from 0.00 to 0.82 resulting in estimates of B_1, the structural form parameter, of 4.007 to 23.906. These results are similar to those arrived at by Zellner and Geisel (1970). Given these findings it was felt necessary to test explicitly the adaptive expectations hypothesis. That is, is it more appropriate for model one to be specified as a partial adjustment model with a normally distributed error term, rather than as an adaptive expectations model with an MA(1) disturbance term where the error term of the original equation is itself autocorrelated?

The partial adjustment model has the original disturbance term which is assumed to be normally independently distributed with a mean of zero and some constant variance σ^2_u, while the adaptive expectations model has an MA(1) disturbance process with the parameter of the MA(1) process, λ, also being the coefficient of the lagged dependent variable, LP_{t-1}.

As emphasised by Waud (1968), the adaptive expectations and partial adjustment models lead to equivalent estimable equations. However, they are conceptually different. The ""adaptive expectations" model attributes the lags to uncertainty and the discounting of current information". On the other hand, "the "partial adjustment" model attributes these lags to technological, institutional and or psychological inertia and the increasing cost of rapid change." (p.205). Waud suggested that when confronted with a situation where a model may be interpreted as being either a partial adjustment or an adaptive expectations model, then the appropriate course of action is to estimate a "nested" or combined model.

The nested model may be written as

$$LP^*_t = B_0 + B_1 R^*_t + u_t \qquad 5.6$$

As can be seen, both the dependent and explanatory variables are unobservable. In essence the maintained hypothesis is that Land Prices move gradually to some desired level given a change in the expected level of net rents.

The estimable form of 5.6 may be obtained by substituting behavioural equations for the unobservable variables. The result is a complex equation where the parameters are non linear and the error term is distributed with an MA(1) process. (See Seed (1986) for a further discussion.)

Doran (1985) discusses three "classical" statistical methods which may be used "when the model of interest can be "nested" or "embedded" in an <u>economically meaningful</u> comprehensive model" (Doran, 1985: p.1). The three asymptotically equivalent tests discussed are, the Likelihood Ratio (LR), Wald (W) and Lagrange Multiplier (LM) diagnostic tests. The three test statistics have unknown small sample distributions, however, they are asymptotically distributed as chi-square, χ^2, with m degrees of freedom where m is the number of restrictions.

By restricting the coefficients of expectation or adjustment in the nested model to take the value of zero the nested model will default, or collapse, to either the partial adjustment or adaptive expectations specification. The Likelihood Ratio test was used to test the validity of these restrictions.

The pure partial adjustment model was estimated by OLS and the pure adaptive expectations model by the Zellner-Geisel two way search technique. The tests indicate that the model depicted in equation (5.5) is more appropriately specified as a partial adjustment process as opposed to an adaptive expectations process. This would mean that real land prices are not a function of <u>expected</u> real net rental income but rather, real land prices <u>adjust gradually</u>, over time, to changes in <u>actual</u> real net rental income. The estimated model is reported in tables 5.1 and 5.2 under the OLS heading.

5.4 <u>Summary</u>

In this chapter we investigated the Melichar hypothesis that real land prices are a function of real net rental income. In doing so we reviewed four alternative estimation techniques and the effect they have on the parameter estimates of equation (5.5). Although the value of the reduced form parameter b_1 did not vary greatly, the magnitude of the parameter on the lagged endogenous variable and consequently the magnitude of the structural form parameter B_1 did fluctuate considerably with the estimation technique. Therefore following the work of Waud (1968) and Doran (1985) the validity of the adaptive expectations hypothesis was tested by formulating the combined adaptive expectations - partial adjustment model and testing the validity of restrictions placed upon the coefficients of expectation and adjustment.

The outcome of a Likelihood Ratio test formulated as an F test suggested that the adaptive expectations hypothesis should be rejected in favour of a partial adjustment process, for this particular model. The implication is that in bivariate models of land price determination, real land prices adjust gradually over time to some "desired" level given a change in real net rental income. Given that the partial adjustment model is the most appropriate specification, the results of the OLS estimation should be used as the appropriate estimates of model one.

Because autocorrelation was present in the estimation of the Z-G one way transformation technique, the two way grid search technique was employed. The autocorrelation may have been due to the disturbance term being genuinely autocorrelated or alternatively it may have been because of misspecification of the systematic part of the model. If the systematic part of the model were misspecified the functional form of the model may have been misspecified. As well a relevant variable (with its associated expectations process) may also have been excluded. What will be the effect of including another variable suggested by theory? This question leads us to the inclusion and testing of additional explanatory variables.

CHAPTER 6

MULTIVARIATE MODELS OF LAND PRICE DETERMINATION

In Chapter 5, the theoretical bivariate expectations model was made operational. As well, a number of estimation techniques were reviewed and the appropriateness of the adaptive expectations hypothesis was tested. In this chapter, models two and three will also be made operational by the replacement of the various expected variables by behavioural hypotheses.

6.1 Model Two: Incorporating Capital Gains

Equation (4.6) expressed land prices as a function of expected rental income and expected capital gains. The maintained hypothesis may therefore be written as:

$$LP_t = Bo + B_1 R*_t + B_2 Cg*_t + u_t \qquad (6.1)$$

where $R*_t$ and $Cg*_t$ are unobservable, $R*_t$ being expected real net rental income and $Cg*_t$ expected real capital gains. Equation (6.1) may be closed by substituting behavioural equations for the unobservable variables $R*_t$ and $Cg*_t$. The result is equation (6.2).

$$\begin{aligned} LP_t = {} & Bo(1-\lambda_1)(1-\lambda_2) + (\lambda_1 + \lambda_2) LP_{t-1} - \lambda_1\lambda_2 LP_{t-2} + \\ & B_1(1-\lambda_1) R_t - B_1(1-\lambda_1)\lambda_2 R_{t-1} + B_2 (1-\lambda_2) Cg_t - \\ & B_2(1-\lambda_2)\lambda_1 Cg_{t-1} + [u_t - (\lambda_1 + \lambda_2) u_{t-1} + \lambda_1\lambda_2 u_{t-2}] \end{aligned} \qquad (6.2)$$

where λ_1 = the coefficient of expectation for net rental income

and λ_2 = the coefficient of expectation for capital gains

Equation 6.2 is a complex relationship where the parameters are non linear and the error term is distributed as an MA(2) process. Because of the manner in which the parameters {Bo, B_1, B_2, λ_1, λ_2} are interrelated it is worthwhile to test the restriction that $\lambda_1 = \lambda_2 = \lambda$, i.e. that the coefficients of expectation of each variable are equal.

The null hypothesis H_o : $\lambda_1 = \lambda_2$ was tested using a likelihood ratio test formulated as an F test and was rejected. The alternative hypothesis that the coefficients of expectation are not equal was tentatively accepted.

The unrestricted model has an MA(2) error term and is non-linear in the parameters. As such, the conventional Zellner Geisel technique will not produce a well behaved error term while addressing the problem of the lagged endogenous regressors. Johnston (1984) offers a solution which addresses both aspects. The technique involves transforming the data matrix and then applying GLS using a covariance matrix constructed using transformations of the values of λ_1 and λ_2. A grid search technique is then employed to find the parameter set which minimises the residual sum of squares.

Results of the estimation are summarised in Table 6.1. Firstly, the signs of the coefficients are consistent with the theory. That is, as expectations of income and capital gains increase, so do land prices.

TABLE 6.1

Summary of Structural and Reduced Form

Parameter Estimates for Model Two

Coefficient	Reduced Form Estimates	Structural Form Estimates
Unrestricted Model		
b_0	0.09013	1.129
b_1	4.646 (3.214)***	8.15
b_2	0.40028 (1.518)*	2.859
λ_1	0.43	
λ_2	0.86	

R^2 = 0.7530; $\bar{R}^2$ = 0.7221
F* = 24.386

(-) = t scores

The structural form coefficients are calculated by dividing the reduced form coefficients by one minus the appropriate coefficient of expectation.

As can be seen the structural coefficient of expected real net rental income is approximately three times that of expected real capital gains. The R_2 and R_2 of 0.7530 and 0.7221 respectively, indicate a reasonably good fit. To test for the presence of any remaining serial correlation, a Lagrange Multiplier test was used, and the first order serial correlation coefficient was signficantly different from zero.

The coefficients of expectation both fell within the acceptable range $0 < \lambda_i < 1$. The estimated value of λ_1, the coefficient of expectation for expected net rentals, was 0.43. This suggests that expectations change reasonably quickly given current experience. The period of time it takes for expectations to change, the mean lag, was calculated to be 0.754 periods. This implies that expectations of net rental income formulated about nine months ago currently affect land prices. The coefficient of expectation for capital gains was estimated to be 0.86. This suggests that expectations concerning capital gains change slowly given current experience. The value of λ_2 of 0.86 indicates that it takes, on average, four and a half years for expectations of capital gains to change.

The finding that expectations of income and capital gains are not formed in the same manner also calls into question the applicability of the often used constant growth valuation model referred to in Chapters 3 and 4. The model assumes that the growth rates of income and asset value are constant into perpetuity. In Chapter 5, a comparison of the growth rates of income and land values provided some evidence that this may not be the case. Furthermore, if the growth rates of land values and income were equal, and constant, then one would expect that the coefficients of expectation would be of a similar magnitude. This is because if the growth rates are the same one would expect the same factors to affect expectations of the value of income and capital gains and they would be formulated over roughly the same time period, hence the mean lags would be of similar length. If this were the case, then the coefficients would be of a similar magnitude. However, they are not.

6.2 Model Three - The Feldstein Hypothesis

The Feldstein hypothesis suggests that real land prices are a function of expected rental income and the expected inflation rate. This was shown in equation 4.4 as

$$LP_t = Bo + B_1 R*_t + B_2 P*_t + u_t \qquad (6.3)$$

where $R*_t$ and $P*_t$ are expected real net rental income and expected inflation. Both $R*_t$ and $P*_t$ are unobservable and as such, the model may be closed by substituting behavioural equations for the unobservable variables in an identical fashion to the manner in which equation (6.1) was closed. The result is equation 6.4.

$$\begin{aligned} LP_t = {} & B_o(1-\lambda_1)(1-\lambda_2) + (\lambda_1 + \lambda_2) LP_{t-1} - \lambda_1\lambda_2 LP_{t-2} \\ & + B_1 (1-\lambda_1)R_t - B_1(1-\lambda_1)\lambda_2 R_{t-1} + B_2 (1-\lambda_2) P_t \\ & - B_2 (1-\lambda_2)\lambda_2 P_{t-1} + [u_t - (\lambda_1 + \lambda_2) u_{t-1} + \lambda_1\lambda_2 u_{t-2}] \qquad (6.4) \end{aligned}$$

where λ_1 = the coefficient of expectation for real net rental income
and λ_2 = the coefficient of expectation for the inflation rate

As with model two, the parameters are non-linear and the error term is distributed as an MA(2) process. If the coefficients of expectation are restricted to be equal, i.e. $\lambda_1 = \lambda_2 = \lambda$, then the model collapses to,

$$LP_t = B_o(1-\lambda) + B_1 (1-\lambda) R_t + B_2 (1-\lambda) P_t + \lambda LP_{t-1} + [u_t - \lambda u_{t-1}] \tag{6.5}$$

The restriction was tested using the same test procedure as that used in model two. The test suggested that the appropriate specification of model three was the restricted model, in contrast to model two where the unrestricted model was the appropriate specification.

TABLE 6.2

Summary of Structural and Reduced Form

Parameter Estimates of Model Three

Coefficient	Reduced Form Estimates	Structural Form Estimates
Restricted Model		
b	0.6807	0.873
b_1	5.773 (3.646)***	7.401
b_2	14.23 (4.429)***	18.244
λ	0.23	
R^2 = 0.6901;	$\bar{R}^2$ = 0.6393	
$F_{(3, 18)}$ = 13.408;	DW = 1.405	

(·) = t scores

The outcome of the estimation of this model was very interesting in that the coefficient for the expected inflation rate was positive and significant. This is counter to both Martin and Heady's (1982) investigation and Alston's (1985) findings. The restricted model suggests that as the expected inflation rate increases, then so do real land prices. This is consistent with Feldsteins (1980a) hypothesis. The coefficients on both real net rental income and the inflation rate are statistically different from zero. The coefficient on real net rental income is also not significantly different from the estimates of b_1 in model two or model one.

The value of λ, the joint coefficient of expectation is 0.23. Given the value of 0.23, the mean lag for both expected variables is 0.28 periods. This indicates that expectations of both income and the inflation rate adjust rapidly to current information, over the space of about three to four months as annual data have been used in this investigation.

6.3 Summary

The estimated structural coefficients of model two were consistent with the theory. That is, the coefficients on both expected real net rental income and expected real capital gains were both positive, statistically significantly greater than zero and of the same order of magnitude. This implies that expectations of both real net rental income and real capital gains were significant determinants of real land prices over the period of observation.

In the case of Model three, the restriction that the coefficients of expectation were equal was tentatively accepted as valid. In contrast to the findings of Martin and Heady (1982) and Alston (1985) the sign of the estimated structural coefficient of the expected inflation rate was positive and therefore consistent with Feldstein's theory. The magnitude of the coefficient of adjustment indicates that expectations of both income and inflation adjust rapidly to current information. This would suggest that expectations of inflation have a significant influence on the real price of land.

CHAPTER 7

SUMMARY AND IMPLICATIONS

7.1 Summary

The objective of this study was to examine the determinants of the price of fattening and grazing farm land in New Zealand over the period 1962 to 1983.

From the literature, three broad themes emerged. The first theme involved the hypothesis that farm land prices were determined solely by the income earned by land. This hypothesis has its roots in the Ricardian theory of land rent, however it has more recently been strongly advocated by Melichar (1979) and (1983). The central tenet of this theory is that land behaves as a growth stock. That is, it is assumed that the growth rates of both the value of the asset and its earnings are constant and equal into perpetuity.

The second theme to emerge from the literature revolved around the notion that although income was an important determinant of the value of farm land, expectations of capital gains also had an effect on land values. This theme was discussed by Castle and Hoch (1982), Plaxico and Kletke (1979) and Bhatia (1971) and (1972) who all emphasised that unrealised capital gains had more value than just the present value of the realised capital gain. Therefore, as well as being an income earning asset, land was also seen as being a vehicle for the storage and preservation of wealth.

The third theme to emerge was probably the most contentious. Feldstein (1980a) and (1980b) hypothesised that expectations of a change in the general price level combined with the structure of the tax laws in the United States lead to an increase in the real price of land and other assets such as gold. That is, the basic neutrality of taxes and inflation broke down when their simultaneous effects were considered.

Having reviewed the theory the next step involved specifying a number of econometric models which could be used to examine the veracity of each theory or hypothesis. Each of the hypotheses involved expectations and to that end each model incorporated an expectations process.

In the first model farm land prices were hypothesised to be a function of expected net rental income. Expectations were assumed to be formed adaptively. That is, it was assumed economic agents revised their expectations of the value of the explanatory variable in each period according to the error in their previous expectations. By substituting a behavioural hypothesis for the unobservable "expected" variable an equation was obtained which had a lagged endogenous variable as a regressor and an MA(1) error term. The result of this substitution was that if the model was estimated by OLS the estimates would not have been "BLUE". That is, they would not have been Best, Linear, Unbiased Estimates of the parameters. However, an estimation technique first described by Zellner and Geisel (1970) was used to transform the equations and therefore neutralise these violations of the Gauss Markov assumptions.

Model two was specified so as to incorporate the hypothesis that real farm land prices were a function of not only expected net rental income but also expected capital gains. In this case both explanatory variables were unobservable and it was therefore necessary to substitute a behavioural hypothesis for each in order to make the model operational. The outcome of such a substitution was a complex relationship where the parameters were non-linear and the error term involved an MA(2) process. The problem of estimating such an equation was overcome by utilising a transformation suggested by Johnston (1984). This was a refinement of Zellner and Geisel's earlier work, and involved a transformation of the X matrix plus the application of GLS using an Ω^{-1} matrix composed of transformations constructed from the coefficients of expectation.

Lastly, model three was specified in a similar way to model two. That is, this model expressed farm land prices as a function of expected net rental income and expected rate of inflation. Because the problems of estimating model three were the same as those encountered with model two, the same estimation technique was employed.

The outcome of estimating model one was quite revealing. The sign of the coefficient of expected income was consistent with our priors and indicated that land values and income were positively related. However, a test of the relevance of the adaptive expectations hypothesis suggested that in fact a more appropriate specification of the model involved the partial adjustment hypothesis. Rather than land prices being a function of expected net rental income, it may have been more appropriate to specify the simple bivariate model as the dependent variable, land price, approaching some "desired" level following a change in the level of net rental income.

Model two was estimated in both a restricted and unrestricted form. A Likelihood Ratio test was used to test the relevance or otherwise of the restriction that the coefficients of expectation were equal. The test statistic suggested that the unrestricted model was a more appropriate specification. In the unrestricted specification, expectations of capital gains were estimated to be formed over a moderate period of time - about four and a half seasons. On the other hand the model also suggested that expectations of net rental income changed relatively quickly, over the course of about one season or less. This could be interpreted as meaning that economic agents formulated expectations of this year's income based on previous year's income plus a small amount of information concerning the current season. With regard to capital gains, the situation is somewhat reversed. In this case, economic agents formulated their expectations over a considerably longer time period and this would suggest that, in a similar manner to Friedman's permanent income hypothesis, capital gains need to be sustained in order for expectations of capital gains to change significantly.

The third model was also estimated in restricted and unrestricted form. In this case we tentatively accepted the restricted model as the appropriate specification. In contrast to previous research by Alston (1985) and Martin and Heady (1982) the signs of the expected variables were in line with the Feldstein hypothesis. That is, as well as an increase in net rental income leading to an increase in real land prices, expectations of an increase in the general price level also lead to an increase in the real price of land.

The unrestricted form of model two proved to be a superior fit of the data, with a higher adjusted R^2, than the relevant versions of other models. The model was consistent with the theory postulated by Castle and Hoch (1982) in that there were two major components of land values. Firstly, the present value of expected future earnings and secondly the expected real capital gains component. The findings suggest that, as in the United States, during the period 1962 to 1983 agricultural real estate investment had been an attractive "farm operator" investment.

The value of the joint coefficient of expectation suggested that expectations of both explanatory variables were formulated exceptionally quickly. Given that annual data were used in the study a mean lag of 0.28 indicated that expectations were revised approximately quarterly.

With regard to the three models it is important to emphasise several points. Firstly, as well as the maintained hypothesis there are a number of auxilary hypotheses which must also be considered. For example, we assume that we have specified the correct set of explanatory variables, the correct functional form, time lags, error terms and so on, Ward (1983). If these auxilary hypotheses do not hold then the validity of the entire model is called into question.

The second point is related to the first. That is, even though model three and model two are consistent with the theory, it is not unambiguous how expectations of inflation or capital gains cause real land prices to rise. For example, it is not clear whether the effect of inflation is felt via Feldstein's portfolio balancing mechanism or whether market participants view land as a repository for their wealth in times of a rising price level and therefore bid up its real price. Although these causes are similar, one acts by equating the marginal returns across various investments while the other is more motivated by speculative forces. Neither is it unambiguous how expectations of capital gains are formulated.

Lastly, in the New Zealand context, there is no real effective capital gains tax levied on capital gains derived from the sale of farm land. Nevertheless if T_c, the rate of capital gains tax, is in fact zero then, as pointed out by Feldstein (1980b), the direction of the price inflation effect on land prices will still be the same. Furthermore, the magnitude of the "correction" in asset prices via the portfolio balancing mechanism will be greater in a situation where T_c is equal to zero.

7.2 Implications for Agricultural Policy

The implications of this study for policy are quite interesting. In the appropriate versions of all three models real land prices were found to be positively related to expected net rental income. That is, an increase by whatever means in expected net rental income or its proxy - the current return to total production assets, leads to an increase in the real price of land, or its proxy - Total Production Assets. This would suggest that an increase in expectations of real farm incomes caused by some form of product price support, income smoothing scheme, input subsidy or general policy set would contribute to an increase in the real price of land. Thus, policies designed to assist a particular group, such as entry level farmers, may only serve to improve the capital position of existing farmers by increasing their expectations of earnings growth. In turn it may become increasingly difficult for entry level farmers to enter the industry in times of rapidly rising farm land prices because they are "crowded out", so to speak, by existing farmers enlarging their land holdings.

The findings of the study suggest that, in an identical fashion, when expectations of real net rental income decrease, so do real land prices. It should be noted that we have referred to expectations of net real rental income and not to actual real net rental income. Thus, occurrences which have a negative effect on economic agents' expectations of net real rental income in turn result in lower real farm land prices. Therefore policy changes which have occurred in the past may have a cumulative effect if the adaptive expectations hypothesis is accepted as the relevant expectations generating process.

The results from the unrestricted estimation of Model two lend some empirical weight to the statements made by Treasury (1984a) and Gould (1982). The implications for policy are that the appreciation in land values which occurred over the period of analysis may be likened to the appreciation which occurs in the value of other real assets such as gold or artwork. That is, land assumes the role of a vehicle for the storage, preservation and appreciation of wealth, rather than that of a productive asset. Moreover, policies promulgated to increase the productive capacity of agricultural real estate may only serve to increase the derived demand for land by decreasing the holding costs of those who see it as a repository for their wealth. An obvious example of these types of policies would be submarket interest rate loans which directly reduce the costs of owning and holding land.

The model with the most interesting result was model three. In this model real land prices were found to be positively related to expected net rental income and also positively related to the expected rate of inflation. This finding suggests an interesting link between micro-level assistance programs and macro-level monetary and fiscal policy.

Firstly, policies such as those mentioned above may serve to increase expectations of incomes, this in turn leads to an increase in the real price of land. However, an aspect which is often overlooked is the method by which these policies are funded. In a large industrialised nation where agricultural output comprises only a very small proportion of GDP and as well the proportion of total government expenditure that is given over to "Vote Agriculture" is relatively small, an escalation of assistance programs to agriculture has little effect on the magnitude of the fiscal deficit.

However in a small nation, such as New Zealand, with a small tax base, and prior to 1984, a comparatively large proportion of total Government spending devoted to agriculture the effect on the fiscal deficit of increasing government payments to agriculture is quite marked. In fact if a nation is running persistent budgetary deficits then the effect of further expansionary fiscal policy can only serve to increase the magnitude of these deficits assuming expenditure is not trimmed elsewhere.

If this same small economy has a fixed exchange rate and a low degree of capital mobility across borders then the manner in which the budgetary deficit is funded will have some interesting consequences. If the budgetary deficit is funded by borrowing from the Central Bank, the upshot will be that the money supply will increase. This also occurs where funds are borrowed offshore if the Central Bank is outside the money supply and is the only purchaser and seller of foreign exchange. Either way the result is an injection of funds into the economy.

The increase in the money supply may result in an increase in the price level as well as an increase in aggregate demand. However, it is the degree to which the expansionary monetary policy affects economic agents expectations of inflation which is of interest here. If buyers and sellers of farm land perceive expansionary fiscal policy, under a fixed exchange rate and with reduced capital mobility, to be inflationary then a link is established between monetary and fiscal policy and microlevel assistance programs. Therefore as well as the direct effects on real land prices of expectations of farm income caused by high profile assistance programs, there are also indirect effects based upon their impact on inflationary expectations caused by their method of funding.

7.3 Suggestions for Further Research

The preceding study has served to emphasise the importance of the role that expectations play in the determination of farm land prices. It must be remembered, that the adaptive expectation hypothesis used in the study assumes that economic agents revise their expectations each period according to the degree of error in their previous expectations. A criticism of the process is that it is not forward looking in any way but rather expectations are built up from an infinity of actual past experience.

An expectations process which does take future information into account was advanced by Muth (1961). This expectations process is known as rational expectations. In the context of this study expectations of net rental income would be hypothesised to be formed by incorporating all of the information available - both past and present. However, the estimation of perfectly rational expectations models is by no means straight forward and for that reason "weakly" rational expectations are often used. However, as pointed out by Carter and Maddock (1984) the expectations are based on underlying economic theory and for that reason are superior to the arbitrarily defined adaptive expectations. Therefore, one direction for future study is the incorporation and testing of the rational expectations process versus the adaptive expectations hypothesis in models of farm land price determination.

A major finding of this study has been the positive relationship established between the rate of general price inflation and the real price of farm land. As already stated above, it is not clear from the estimation results whether the effects of inflation are felt through the portfolio balancing mechanism or whether economic agents regard investment in land as a "hedge" against inflation. Therefore, a further direction for future research may be the development of a portfolio balancing model. Furthermore, such a model could be usefully incorporated into a

Furthermore, such a model could be usefully incorporated into a general equilibrium macroeconomic framework which would in turn enable a closer examination of the link between micro-level assistance programs and macro-level policies.

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Abbreviations used in this bibliography

AAEA American Agricultural Economics Association

AAES Australian Agricultural Economics Society

AJAE American Journal of Agricultural Economics

AER American Economic Review

JFE Journal of Farm Economics

JME Journal of Monetary Economics

SJAE Southern Journal of Agricultural Economics

WJAE Western Journal of Agricultural Economics

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