FACTORS INFLUENCING NET INVESTMENT DECISION MAKING FOR A GROUP OF LOWER NORTH ISLAND SHEEP AND BEEF FARMERS

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Paul James O'Neil

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To my wife Sandy, my unending gratitude for support of what was a selfish ambition.

ABSTRACT

This study investigated the process of net investment decision-making on a group of New Zealand sheep and beef farmers. A review of previous theoretical and empirical research led to the study's objectives, namely to test that investment decision making on New Zealand farms could be incorporated in two dimensions: the determination of a desired level of capital stock and a description of the rate of adjustment of actual capital stock to the desired level.

A study of net investment decision-making was chosen because net investment was seen by policy-makers in the 1970's to be an ingredient in planned growth in output. Information on net investment at the individual farmer level was not, however, available to policy-makers at the time. The study was at the individual farmer level to complement previous reserarch at the macro-level on investment in the New Zealand pastoral sector.

An investment model was tested using ordinary least squares combining time-series and cross-section data. The initial specification included individual farm dummy variables to account for cross-sectional differences in net investment decision-making. Later, candidate variables hypothesised as explaining cross-section differences were included in the model.

The regression results led support to the study's objective. Demand for desired capital stock was viewed as determined by Government policy measures, farm size, farmer age and the initial development state of the farm. Adjustment of actual capital stock to the desired level was viewed as determined by the level of cash at the beginning of each period and windfall gains or losses in net income in the current period. The results provide some basis for the better targeting

ABSTRACT (Cont'd)

of future policy measures to the farm sector.

The study was limited by lack of a priori knowledge of inter-farm differences in the desire for capital, by the lack of a precise measurement of actual capital stock and the failure to account for interdependencies in the consumption-investment decisions that take place on farms. These limitations could provide avenues for future research.

Chapter One

Introduction to the Study

1.1 Introduction

This study is concerned with an explanation of net investment on a group of New Zealand sheep and beef farms from 1973/74 to 1980/81. Because of the impact on New Zealand's economic growth due to growth of the agriculture sector, an investigation into one of the vehicles of growth, namely investment, is of interest to policy-makers.

The period from the early 1970s to the early 1980s was one of considerable uncertainty for farmers. This was a period when inflation, product price variability, weather variability and Government policies combined to influence the environment in which farmers made their production and investment decisions.

The climate for most of this period was kind with mild winters, wet springs and enough summer and autumn showers to give adequate pasture growth throughout the year. This pattern was interrupted twice. In 1972/73 much of New Zealand experienced a cold winter followed by a serious summer drought. It was not until the winter of 1974 that rains were sufficiently heavy to build up soil water reserves. The 1977/78 season was again a very demanding one, especially for Wairarapa farmers. Rainfall in this region in the winter of 1977 was 190 percent of the 30 year average resulting in severe flooding and landslips. This was followed by a summer drought with rainfall 60 percent of the 30 year average.

These random events may have made farmers pessimistic about the profitability of certain investment projects, particularly where high stocking rates were evident. On the other hand, these random events may have encouraged investment in certain capital inputs such as provision of supplementary feed facilities and water schemes.

The market environment over the period was a difficult one for farmers. As Table 1.1 shows, farmers faced a declining terms of trade which at the time may not have enhanced farmers optimism about the profitability of additional investment.

Table 1.1: New Zealand Sheep and Beef Farms Terms of Exchange

Year	Prices Received Index	Prices Paid Index	Terms of Exchange Index
1970/71	594	617	963
1971/72	580	656	884
1972/73	940	690	1362
1973/74	940	787	1194
1974/75	669	892	750
1975/76	1000	1000	1000
1976/77	1261	1186	1063
1977/78	1202	1371	877
1978/79	1480	1496	989
1979/80	1753	1831	957
1980/81	1957	2264	861

Source - New Zealand Meat and Wool Board' Economic Service.

Product prices generally increased over the data period. If farmers believed at the time that inflation was a temporary phenomenon, farmers could have been optimistic about expectations of future income. However, the relative prices of the major products changed over the data period. The wool boom in 1972/73, coinciding with high prices for sheep and cattle meat, continued into 1973/74. Beef prices reached an all-time high in 1973/74. In the autumn of 1974 beef and sheep prices plummeted. This continued into the 1974/75 season.

In 1975/76 product prices improved some 50 per cent and continued rising in the 1976/77 season. Sheep meat and wool prices, however, moved more significantly than cattle meat prices. On East Coast farms at this time, the return on a sheep stock unit was 145 percent greater than for a beef stock unit. In 1977/78 this situation began to reverse. Wool and lamb prices were checked while beef prices increased. All prices continued to rise throughout the remaining years of the data period, with beef prices in 1978/79 exceeding the record prices of 1973/74. Such changing relative prices may have had an influence on input use. In particular, the greater returns from sheep may have encouraged greater use of feed control systems requiring subdivision fencing, water supply and supplementary feed capital inputs.

Because of the linkages among export receipts from the pastoral sector and employment and economic growth in New Zealand, the Government in turn attempted to positively encourage output from the pastoral sector. A major emphasis by Government over the period was to stabilise farmers' incomes. In response to the boom years of 1972/73 and 1973/74, the Government of the day introduced a voluntary income stabilisation scheme and encouraged farmers (with the threat that such a scheme could be made compulsory) to commit sums to a target total of $85 million. It transpired that such a deposit proved a saviour to many farmers in the 1974/75 season when product prices fell, although it is uncertain what farmers would have done with the money in the absence of such a scheme. Under the encouragement of Government, farmers as a group, through their Meat and Wool Boards, introduced in 1976 a permanent income stabilisation scheme. This scheme guaranteed a minimum price for meat and wool products and set a trigger price at which level receipts were to be deposited in the stabilisation fund. In 1978 the Government superimposed on this permanent scheme its own scheme, a supplementary minimum price (SMP), guaranteeing a minimum price for the coming and subsequent season. The SMP was about to finish at the time of writing this study.

There is some speculation as to the effectiveness of income stabilisation in encouraging productive investment. A prominent New Zealand view was that farmers had a high propensity to invest out of the previous year's income so income stabilisation was good. Another view was that farmers had a higher propensity to invest when incomes were unstable so that income stabilisation was bad. At the time of the introduction of the income stabilisation scheme, however, it was favourably received and probably contributed to a wave of optimism over future income expectations.

So that it could concentrate on the capital needs of the pastoral sector, and to ensure that development of this sector was not hindered by inadequate medium-term finance, the rural lending activities of the State Advances Corporation were reconstituted by the Government in 1973 into the Rural Banking and Finance Corporation. This long and medium term source of finance has been at concessional interest rates. Perhaps more significantly, the Rural Bank acted as the Government agent in directing development expenditure towards specific capital inputs.

Two schemes were of particular prominence during the period. The first, the Livestock Incentive Scheme rewarded a farmer for permanently increasing the numbers of livestock he carried on his farm. This reward came in the form of a $12 cash grant or a $24 deduction in assessable income for each stock unit increase above a certain minimum increase. This scheme begun in 1977 and continued into the 1980s. The other scheme, began in 1978 and continued into the early 1980s, encouraged farmers to rapidly improve reverted or undeveloped farmland, including previously untopdressed pasture. Known as the Land Development Encouragement Loan, this scheme provided a grant of $250 per hectare to develop the farmland for a term of 15 years at concessional interest rates. Provided the development was permanent, the interest was deferred and written off at five-yearly intervals and one half of the sum advanced was to be written off at the end of the tenth year of the loan. Loan repayments did not have to begin until five years after the sum was advanced.

Both these schemes were well accepted by farmers, with 13,800 authorisations of $128 million for the loan option of the LIS between 1976/77 and 1982/83 and 7,500 authorisations of $151 million for the LDEL between 1978/79 and 1982/83.

The Government had also over the period of study directed expenditure on certain capital inputs through the use of input subsidies and taxation and investment allowances. Fertiliser subsidies were in operation throughout the data period. These mainly existed to encourage such expenditure when farm incomes were low. Prior to 1973/74 price subsidies existed on fertiliser, its cartage and application, on pesticides, weedicides and animal drenches. The buoyant conditions of 1972/73 led the Government in 1973 to lower the subsidy on fertiliser and its cartage and to remove the subsidies on the other inputs. The downturn in product prices and incomes in 1974/75 resulted in the fertiliser price being held at the 1974 price level and the reintroduction of spreading bounties and subsidies on pesticides and weedicides. The higher income years of 1975/76 and 1976/77 resulted in the fertiliser price subsidy being reduced in both years. The climatic vagaries affecting farm incomes nationally in 1977/78 led to a substantial increase in fertiliser subsidies in that year, although the spreading bounty was abolished. In 1979 Government philosophy changed against fertiliser price subsidies which were reduced substantially, remaining so into the early 1980s.

The Government actively promoted general investment expenditure and expenditure on specific capital inputs through taxation and investment allowances throughout the data period. All development expenditure could be claimed as current operating costs, either in the year of expenditure if the amount spent was small, or spread over nine years (three in the case of fertiliser) if the amount spent was large. Farmers had the opportunity to fix the values of their livestock. New entrants or those increasing livestock numbers could benefit from the Nil Livestock Values Scheme. Expenditure on fixed assets was encouraged by the Government through generous depreciation and investment allowance. Ordinary depreciation allowances on buildings and plant and machinery were constant over the data period. The most common depreciation allowances included 2½% C.P. on wooden buildings, 10% C.P. on covered yards, 10% D.V. on most items of plant and machinery and 20% D.V. on vehicles. Other allowances made such expenditure more attractive in reducing assessable income.

From 1973/74 to 1975/76 a special depreciation allowance up to 20% was allowable on the cost price of plant and machinery and new buildings and extensions other than residences. In these years an investment allowance of 20% was allowable on the purchase of new plant and machinery. This system was replaced in 1975/76 with first year depreciation allowances of 60% on new plant and machinery, 50% on second-hand plant and machinery and 40% on buildings. In 1976/77 the first year depreciation allowance on all plant and machinery was reduced to 25% but an investment allowance of 40% was made available. In 1979/80 the first year depreciation allowance on buildings was reduced to 20% and the investment allowance on plant and machinery was reduced to 20%.

Any of these market and institutional changes that occurred over the data period could have led to changes in the farmers' perception of future profitability of investment projects. The pattern of real gross investment on New Zealand farms over the 1970s reflected the market and institutional influence faced by the agriculture sector over the period. Table 1.2 shows real gross capital expenditure in various capital aggregates over the 1970s. Those years in which the terms of trade were more favourable (1971/72, 1972/73, 1975/76, 1976/77) were years where increases in gross capital expenditure occurred. In particular, the two years when the terms of trade were most favourable, 1971/72 to 1972/73, were years when annual gross capital expenditures were the largest, not being exceeded for the remainder of the period.

Of the various capital aggregates, only buildings did not show a large decrease in expenditure when the terms of trade fell in 1974/75. The various capital aggregates show similar patterns of expenditure. Expenditure increased in 1971/72 and 1972/73, spectacularly in the case of transport vehicles, to fall in 1974/75. Gross capital expenditure on all capital aggregates tended to be static over the middle 1970s, although at higher levels to that experienced before 1970/71. From 1977/78 to the end of that period gross capital expenditure in each capital aggregate showed a steady annual increase. The pattern of sustained, then increased, gross capital expenditure from the mid-1970s on occurred in an environment of declining terms of trade. It is clear some events were occurring to modify farmers' expectations as to the profitability of gross investment in this period of low terms of trade. The various policy measures mentioned in section 1.1 could have been an ingredient in this process.

1.2 Objective of the Study

The primary objective of this study is to determine the factors that influenced farmers' decision-making with respect to capital investment over the 1970s. Reference has already been made to market and institutional factors which may have influenced such decision-making.

Table 1.2: Real Capital Expenditure on Farms $(000)

(Base year 1970/71)

Year[1]	Buildings[2]	Construction[3]	Transport Vehicles	Tractors and Farm Machinery	Other Improvements[4] and Development	All Groups
1970/71	34,080		25,503	28,180	38,827	127,590
1971/72	29,629	7,144	37,094	34,352	26,630	134,849
1972/73	35,268	9,627	55,850	39,947	36,198	176,890
1973/74	44,003	9,032	48,046	39,733	40,921	181,735
1974/75	46,757	7,534	29,739	31,975	29,011	145,016
1975/76	42,964	8,333	33,275	35,069	29,944	149,585
1976/77	45,121	8,063	33,001	37,868	29,556	153,609
1977/78	41,161	8,088	26,627	27,869	28,330	132,075
1978/79	38,382	8,536	34,854	36,241	35,573	153,586
1979/80	45,059	9,199	38,934	34,348	37,878	165,418
1980/81	50,437	9,043	40,212	33,796	40,653	174,141

1 Prior to 1973/74 year ended 31 March, from 1973/74 year ended 30 June

2 Prior to 1973/74 buildings also included construction

3 Includes permanent yards, roading, bridges, airstrips, water supply systems, dips and sprays

4 Includes working animals.

Source - Department of Statistics Agriculture Statistics 1981/82 deflated by Farm Capital Expenditure Price Index

Johnson (1971), in one of the few studies of investment on New Zealand farms, pointed out that net investment was the important policy aggregate as it was additions to the capital stock that provided for growth. The official statistics on capital expenditure referred to in section 1.2 related to gross investment. Johnson pointed out that gross investment levels were an inadequate guide to current net investment in the agricultural industry, and could lead to policies that would jeopardise the expansion of the industry. Because net investment is the important policy variable, this study will consider only the net investment component of capital investment.

The major recent studies on New Zealand farm investment behaviour have been at the national level. A study at the individual farmer level, by removing the problems of aggregation across farmers would compliment previous work. The focus of this study will therefore be at the individual farmer level.

1.1 Outline of the Study

Chapters Two and Three review the literature on investment decision-making in order to draw upon the experience of other researchers. A testable hypothesis supposes investment to be the simultaneous solution of two processes. The first process is the identification of a gap between the current level of capital stock and a desired level of capital stock. The second process concerns itself with how quickly this capital gap is removed.

This study derives an investment model for net farm investment. Thus it was necessary to construct a data base from which this variable could be estimated. The process of data collection is presented in Chapter Four.

A brief description of the farms in the study is presented in Chapter Five. This description highlights the different levels of capital development of the farms in the study.

An investment model is introduced and tested empirically in Chapter Six. The investment model is estimated from combined time-series and cross-section data of the farms surveyed.

The study concludes in Chapter Seven with a discussion of the implications that were implied by the results of the empirical analyses. The model was also re-examined in terms of its shortcomings in predicting investment behaviour.

Finally, in the light of the shortcomings of the model, improvements to the model as subjects for further research are suggested.

Chapter Two

A Review of Theories on Investment Decision-making

2.1 Introduction

This chapter draws upon the experience of other researchers to discover from the available information what is currently known about farmers' investment decision-making. This review will therefore orient the study to some testable hypotheses on farmers' investment decision-making.

The nature of capital as a productive resource, the problem of capital measurement and the link between capital and investment is first discussed. Various theories of investment behaviour are then described. This is followed by a review of some empirical studies. The concluding section summarises the findings of the information search. It also discusses the information obtained in terms of its potential for explaining the investment behaviour on a sample of New Zealand sheep and beef farms.

2.2 Capital in the production process

Investment concerns the time rate of change in the level of capital stock. Defining capital stock, however, is a problem since it is difficult to define capital as a physical object without referring to its economic functions. The choice of some a priori statistical criterion to define capital goods usually ends up with a heterogeneous collections of objects. On the other hand, if capital is defined by reference to the economic functions that all capital has in common, difficulties are experienced in measuring the amount of capital.

Capital has the dimensions of a stock. There are two schools of thought, however, on how the stock enters the production process. The Austrian school considers the stock of capital as doing nothing in the production process. Capital was merely present as a consequence of some method of saving the original factors, labour and land. Modern ideas view the production process in terms of a production function where output is determined by levels of certain physical objects, including capital. This still leaves the problem of defining in what sense capital 'goes into' a product.

Superficially, the depreciation or depletion of the capital stock enters the production process. This would, however, suggest that other circumstances require buildings or fences on a farm when the requirement was for a flow of input corresponding to the rate of depreciation. For the purposes of this study the technological view prevails that regards capital as present in the production process and yielding a productive service per unit of time.

2.2.1 The problem of measuring the capital service flow

Capital, being a multi-period input to production, contributes a major part of its services to future rather than to current production. Single period production theory, however, concerns itself with current services thus only the current service flow of capital belongs as an input to the current period's production function. The flow of capital services per period in a perfect market could be approximated by the rental price of capital per period times the units worked in that time period.

Unfortunately data on work units performed by capital assets is unavailable. By assuming the amount of capital services to be proportional to the amount of capital stock, capital stock is commonly used as a proxy. In Jorgenson's (1971) survey of econometric studies of investment behaviour of industrial firms, all reported studies used this proxy.

Yotopoulos (1967), however, showed the proportionality property very hard to satisfy. He compared the service flow to capital stock on an algebraic model supposing a production function with homogeneous capital inputs. Each capital input had the same durability and age, and produced a constant stream of services. By relaxing the durability and age assumptions, Yotopoulos showed the use of capital stock concept instead of the service flow concept placed more weight on the more durable capital good.

When the assumption of a constant stream of services was relaxed, he showed that the ratio of stock to flow decreased with age and at any point in time was greater for assets that had greater durability and/or were of a later vintage.

2.2.2 The measurement of capital stock

As Jorgenson (1971) observed, the measurement of net investment and capital stock are closely related. Because gross investment, defined as the sum of net and replacement investment, was the more easily measured variable, capital stock series were built up from a base year valuation of capital stock using the identity.

$$K_{t+1} = K_t - d_t + GI_t \tag{2.1}$$

where: K_{t+1} = capital stock in year t+1

K_t = capital stock in year t

d_t = the depreciation in capital stock in year t

GI_t = gross investment in year t

The amount of capital stock present at the beginning of the following year was calculated as the base amount less physical depreciation plus gross investment. Net investment was calculated after assuming some model of replacement investment decision process. Measurement of a time series of capital stock therefore required an assumption about the rate of depreciation

Yotopoulos (1967) distinguished two components of depreciation, physical depreciation and market depreciation. The former consisted of the extent to which the capacity of the asset to supply current services had decreased. Market depreciation dealt with the decline in the economic value of the current and all future services derivable from a given capital stock.

Griliches (1960) considered deterioration or decay as the reason for a decrease in the physical productivity that may attend an assets aging and/or use. This decrease appeared in the form of rising operating or maintenance costs with each successive period of production, in expense due to lost time, or in less output per unit of time.

Market depreciation includes physical depreciation and more. Yotopoulos (1967) further defined two factors that entered into market depreciation, namely exhaustion and obsolescence. Exhaustion was defined as the differential that the market attached to the fact that there was one year less of life in the asset and that the future configuration of the service stream would no longer be the same. Obsolescence was defined as the penalty attached to old capital items because of the probability of better machines becoming available.

Market depreciation ought therefore be the measure of d_t in equation (2.1), formally measured as the change in an asset's present value discounted at the appropriate rate of interest. Several obstacles negate a precise expression of this value:

(a) The future life of the asset cannot be predicted with accuracy.

(b) There may not be one pattern of yield but many depending on use.

(c) Estimates of future yields may be highly uncertain.

(d) For most assets the concept of a net yield would be meaningless because of the capital asset's collaboration with other inputs in producing the final product.

2.3 Investment in a single good economy

2.3.1 No capital market

Fisher (1930) and Hirschliefer (1958) considered the determination of the optimal capital stock by a decision maker who was both a producer and a consumer and whose objective was to maximise utility over time. The analysis was conducted assuming an economy with a single good that served as both a capital and consumption good.[1]

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1. This assumption allowed measurement of both goods in terms of a common physical unit. This meant that the relative prices of capital to consumption goods could exogenously be given as one.

The producer, endowed with a stock of the good, wants to decide on the level of consumption over two periods. Given a certain production function, the producer knows at what rate goods invested this period will yield goods for consumption next period. In order for the producer to maximise his utility subject to the constraint of the production function, he needs to choose that stock of the good that would get him on the highest attainable indifference curve.

The Fisherian analysis indicated that the producer's optimal consumption plan was when the marginal product of capital equalled the marginal rate of time preference. The important point of this analysis was that it showed clearly that the opportunity cost of capital acquisition was foregone present consumption and that the basic choice was between consumption at different periods of time.

2.3.2 Introduction of a capital market

Hirschliefer (1958) applied the Fisherian analysis to individual choice in a decentralised market economy. In addition to the assumptions in section 2.3.1, the individual could borrow or lend the good on a perfectly competitive market at an exogenously given market rate of interest. The important point that emerged from this analysis was that in a world of certainty and a perfect capital market, the decision concerning the desired quantity of capital to place in the production process (the investment decision) could be made separately from the consumption decision. To determine the optimal amount of investment in production the individual's utility function need not be known. It was sufficient to aim at maximising net present value from investment in production to arrive at the optimal capital stock.

Net present value from investment in production can be expressed algebraically as:

$$PV = C_o + C_1/(i + 1) \qquad (2.2)$$

where: PV = net present value

C_o = the amount of the good received this period

C_1 = the amount of the good received next period

i = exogenous market rate of interest

For the individual to maximise net present value in the two-period model, he acquires capital until;

$$dC_1/dC_o = -(i + 1) \tag{2.3}$$

That is, until the marginal productivity of capital stock equals the market rate of interest.

It is implied that for the individual to maximise net present value, each capital project will be adopted so long as its net present value is greater than zero.

2.3.3 Determination of the desired stock of capital in the certainty model

The analysis in section 2.3.2 extends easily to more than two periods. It can be deduced that the net present value of any capital project will be greater the lower the cost of capital goods, the lower the market rate of interest, and the higher the expected net revenue. It is therefore predicted in the certainty model that an individual's desired stock of capital will vary inversely with the cost of capital goods and the market rate of interest, and will vary positively with the level of expected net returns.

2.4 The neoclassical theory of the firm

The analysis of Section 2.3 concentrated entirely on the decision regarding the quantity of capital to hold and did not consider labour specifically. Capital was analysed differently from labour because in modern societies labour services were typically hired. Labour services were a flow input for which the price paid was for services given per period of time. On the other hand, firms typically bought a stock of capital which would yield services over a number of time periods and for which an initial sum was paid.

Jorgenson (1965) analysed an investment model for a firm that made production decisions which involved future as well as present time periods, and that considered the amounts of capital and labour to hold. Jorgenson assumed that a firm combined capital and labour to produce output in situations where prices of factors and goods were known with certainty, where there was a perfect capital market, in such a way as to maximise net present value. Two constraints restricted the firm's behaviour. A Cobb-Douglas production function and an identity relating capital investment and depreciation. Jorgenson used continuous time and set out his model as;

$$\max.\ PV = \max. \int_0^{\infty} e^{-rt}\ [pX - sL - qI - u(t)]\ *$$
$$\{pX-sL-q[v(t)\delta+w(t)r + x(t)\dot{q}/_q]k\}\ dt \qquad (2.5)$$

subject to: $X = AK^{\alpha}\ L^{\beta}$

$\dot{K} = I - \delta K$

where: δ = depreciation rate

$u(t)$ = tax rate on net income

$v(t)$ = tax allowance on depreciation

$w(t)$ = tax allowance on debt

$x(t)$ = tax allowance on capital loss

A = constant

$\dot{K}$ = rate of change of K

$\dot{q}$ = rate of change of q

e = exponent for continuous discounting

K = stock of capital

X = output

L = labour

I = investment

r = market rate of interest

p = price per unit of output

q = cost per unit of capital good

s = wage rate

Using the calculus of variations, Jorgenson derived the necessary conditions for utility maximisation as;

$$\frac{dX_t}{dL_t} = \frac{s_t}{p_t} \tag{2.6}$$

$$\frac{dX_t}{dK_t} = \frac{c_t}{p_t} \tag{2.7}$$

Where: $$c_t = q[(\frac{1-uv}{1-u})\delta + (\frac{1-uw}{1-u})r - (\frac{1-ux}{1-u})^{\dot{q}}/_q]$$

(2.8)

Equations (2.6) and (2.7) were the usual conditions that equate marginal products with the inverse price ratios. The dynamic problem was reduced to a simple static problem. In each time period, the profit maximising firm would select that ratio of capital to labour which maximised profits. The relative cost of capital to labour and the price of the product determined the optimal capital stock in each period. If factor costs changed over time, so would the optimal capital stock, so that a time path of investment could be derived. Any change to capital stock was instantaneous.

The term c_t in equations (2.7) and (2.8) was the flow price of capital.[2] Thus the cost of the capital stock, which consisted of a lump sum supply price plus the opportunity cost of holding the capital stock in each period, was converted into a cost per period of a unit

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2 Jorgenson termed c_t the 'user cost of capital'

of capital services. This cost (the component in square brackets in (2.8)) consisted of the post-tax depreciation of the capital stock per period of time, plus the post-tax opportunity cost, less the post-tax rate of appreciation of the capital stock.

2.5 The accelerator theory of investment

The accelerator theory of investment emphasised the relationship between the capital stock and the flow of output.[3] The optimal capital-output ratio occurred when the capital stock was operated at a level of capacity utilisation which minimised costs. When the actual and optimal capital-output ratios were equal, the rate of profit on capital was such that the firms' investment policies were to neither increase nor decrease the ratio of capital to output.

The desired stock of capital was therefore related to the volume of output the firm planned to produce by means of the optimal capital-output ratio. This relationship can be expressed algebraically as,

$$K_t^* = zX_t^e \qquad (2.9)$$

where: K_t^* = desired capital stock in year t
z = the capital-output ratio
X_t^e = planned output in year t

With pressure on capacity the expanding firm would add to the capital stock in order to produce more output. The desired capital stock which the firm wished to hold at the end of the current period in order to produce next period's output optimally, was related to the expected volume of future output.

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3 This theory is reviewed by Junanker (1978)

If the difference between the actual capital stock with which firms started the period, and the desired capital stock, was entirely made up within the period, net investment was given by:

$$I_t = K_t^* - K_{t-1} = z\ (X_t^e - X_{t-1}) \qquad (2.10)$$

where: I_t = net investment in year t
K_{t-1} = actual capital stock in period t-1
X_{t-1} = actual output in previous period

K_t^*, z, X_t^e is as previously defined

If the existing capital stock was not fully utilised, net investment was smaller. Equation (2.10) can be modified by subtracting that portion, b, of the capital stock that was currently under-utilised.

$$I_t = z\ (X_t^e - X_{t-1}) - bK_t \qquad (2.11)$$

where: $0 < b < 1$

Equation (2.10) and (2.11) are the basic versions of the accelerator theory which relates net investment to the expected increase in output times the optimal capital-output ratio. The incremental capital-output ratio z, was assumed to be constant.

2.6 The time structure of the investment process

2.6.1 Introduction

The investment models described in previous sections hypothesised relationships between certain variables and net investment, but only through their impact on the desired stock of capital. The twin assumptions of certainty and perfect capital markets resulted in actual capital stocks being allowed to adjust instantaneously to the desired level. On removal of such assumptions, the possibility of lags in the adjustment of actual capital stock to the desired level can be recognised. Haavelmo (1960) argued that 'the demand for capital ... demand for a finite addition to the stock of capital could lead to any rate of investment depending on the additional hypotheses introduced regarding the speed of reaction of the capital users'.[4] Thus a capital theory which predicted the demand for desired capital only gave the shortage to be made up. It did not describe the rate per period of time at which the shortage must be removed.

Three theories have been proposed to account for adjustment lags.

(a) Lags caused by adjustment costs
(b) Lags caused by subjective, institutional and technical factors
(c) Lags explained by the availability of funds.

These are discussed in the subsequent sub-sections.

2.6.2 Lags caused by adjustment costs

Eisner and Strotz (1963), Lucas (1967), Gould (1968) and Treadway (1970) among others, supposed that the magnitude of the capital stock could be changed only by incurring adjustment costs. These costs were a function of gross investment and were generally assumed to rise at an increasing rate. The justification of adjustment costs was associated with the notion that there were costs associated with the sale, purchase or productive installation of capital goods over and above the basic price of the goods. On a New Zealand farm, the disruption to normal farming routines as a result of land development could be considered an adjustment cost. To minimise such disruption a land development project may be spread over several years rather than completed in the one period.

Few empirical studies on investment that embody a rigorous adjustment cost theory have appeared in the literature. Rather, most assume some ad hoc mechanism.

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4 Haavelmo (1960), p.126.

2.6.3 Lags caused by subjective, technical and institutional factors

Koyck (1954) organised his discussion of delays in adjustment into subjective, technical and institutional factors. Subjective factors reflected psychological inertia due to habit or risk aversion and the desire of entrepeneurs to wait and see more evidence of changed demand conditions. Institutional factors may cause lags in response due to such phenomena as the financing institution only deliberating on loans at regular intervals. An institutional lag common in New Zealand agriculture is the Rural Bank at times only having loan monies available for particular projects. Technical lags recognise the fact that the ordering, production and delivery of investment goods takes time.

Due to Chenery (1952), the mathematical expression of this lag process has become known as the flexible accelerator model of investment. In his model it was assumed there was some optimal relationship between capital stock and output, but changes in the level of desired capital were transformed into actual investment expenditure through a geometric distributed lag function. This was expressed algebraically as;

$$K_t = z\ (1-\lambda) \sum_{i=0}^{\infty} \lambda^{i}\ X_{t-i}\ (o < \lambda < 1) \qquad (2.13)$$

where: the weights are:

$$(1-\lambda) + (1-\lambda)\lambda + (1-\lambda)\lambda^2 + \ldots + (1-\lambda)\lambda^i + \ldots = 1,$$

and K_t, z, X_t are as defined in Section 2.5.

Using the Koyck transformation equation (2.13) evolved to:

$$K_t - K_{t-1} = (1-\lambda)\ zX_t - (1-\lambda)\ K_{t-1} \qquad (2.14)$$

By assuming that in the long run the capital stock would have reached its desired level, $K_t^* = K_t = K_{t-1}$.

Since $K_t^* = zX_t$, equation (2.14) became:

$$K_t - K_{t-1} = (1-\lambda)\ K_t^* - (1-\lambda)\ K_{t-1},$$

gathering terms,

$$K_t - K_{t-1} = (1-\lambda)\ (K_t^* - K_{t-1}) \qquad (2.15)$$
$$0 < (1-\lambda) < 1$$

Equation (2.15) is the usual form of the flexible accelerator model of investment. According to this, net investment was some fraction of the difference between desired capital stock and actual capital stock in the previous period. The coefficient $(1-\lambda)$ described how quickly the adjustment took place.

Jorgenson (1971) in his survey of econometric studies of investment behaviour of industrial firms concluded that 'the flexible accelerator model of Chenery and Koyck... has gradually modified and extended under the impact of new empirical findings, but its basic outlines have found substantial empirical support.'[5] This model has not been used much in farm investment studies.

2.6.4 Lags explained by the availability of funds

Coen (1968) proposed the combination of flexible accelerator and profits models of investment. Since then, several empirical applications have been reported, particularly in the literature on investment in the Australian agricultural sector. Coen proposed that the level of desired capital stock may be determined by the desired level of output (or relative prices), but that the time structure of the investment process was a function of the internal liquidity of the firm. This was expressed algebraically as,

$$K_t - K_{t-1} = b_t\ (K_t^* - K_{t-1}) \qquad (2.16)$$

where: $b_t = f\ (Y_{t-n})$

Y_{t-n} = appropriately lagged liquidity variables

5 Jorgenson (1971), p. 1141

Glau (1965), in a study of the influence of taxation on Australian farmers, applied this formulation with the rationale that the income effect of taxation 'operated on the internal liquidity of the firm and would affect the rate of adjustment from the existing stock of capital owned by the farmer to that stock of capital which he desired to own.'[6]

This specification of a variable rate of adjustment dependant upon liquidity also allowed recognition of Campbell's (1958) theory on residual income. Campbell proposed that a transitory (or unexpected) component of income determined the rate of farmers' investment. Thus farmers who experienced fluctuating income were expected to have higher marginal propensities to save, and therefore a higher rate of capital accumulation, than those on more stable incomes.

Girao et al (1974) included a measure of transitory income in their investment study of a group of USA farmers, and found that farmers with unstable incomes based their investment expenditure on the transitory component of income, whereas farmers with stable incomes considered savings to be a more important determinant of investment expenditure.

Waugh (1977) in an econometric study of a group of Australian sheep farmers followed Glau in modifying the flexible accelerator model as given by equation (2.16) by allowing the speed of adjustment to be a linear function of internal liquidity relative to desired investment. Thus,

$$b_t = b_1 + b_2\, Y_{t-1} \,/\, (K_t^{*} - K_{t-1}) \tag{2.17}$$

where: b_1 and b_2 = constants to be determined,
Y_{t-1} = the level of internal liquidity in the previous period.

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6 Glau (1965), p.213

By substituting expression (2.17) into equation (2.16), the expanded model was written up as,

$$K_t - K_{t-1} = b_1 (K_t^* - K_{t-1}) + b_2 Y_{t-1} \qquad (2.18)$$

Cornell and Kerridge (1978) in their survey of the indebtedness of Australian sheep farms between 1956 and 1976, found indebted farms to spend a more-than-proportionate amount of net income on gross investment than did debt-free farms. To test this result, Waugh included the change in real debt as part of the adjustment function, to result in the following specification:

$$K_t - K_{t-1} = b_1 (K_t^* - K_{t-1}) + b_2 Y_{t-1} + b_3 D_t \qquad (2.19)$$

where: b_3 = a constant to be determined
D_t = change in real debt

2.7 The behavioural approach to investment decision-making

Stanbridge (1972), in his study of the rural credit market in New Zealand, based his study on the individual farm firm. He defined the farm firm in a behavioural rather than an economic context. In doing so he assumed there was a close relationship between the goal(s) of the firm and its owners. The assumption was made that the farm firm has multiple goals and that it moved to these goals in a subjectively rational manner. Quoting Simon (1959),[7] Stanbridge criticised the economic context as;

(a) being vague as to whether short-term or long-term profits were referred to;
(b) Farm entrepeneurs particularly may receive 'physic income' as a supplement or complement to economic income;
(c) the theory included only a small number of variables;
(d) because of uncertainty, expectations were formed with limited knowledge and firms were unlikely to be able to maximise profits ex post;

7 Simon (1959), p.262

(e) in practice, firms did not invest close to the margin;

(f) firms had other non-economic goals and these may dominate decision-making;

(g) in practice, firms may use short-cuts and past experience in making decisions.

Behavioural theories, according to Stanbridge, shared the premises that firms' goals were something other than maximum profit, and that profit maximisation was an unattainable goal anyway. Quoting Simon,[8] Stanbridge introduced the concept of 'limited bounded rationality' - that is, that people were as rational as possible within limits, and income satisficers - that is, a rate of profit or income was satisfactory if it earned a return at least equal to an aspiration level. The measurement of satisfaction as the primary firm goal necessitated the adoption of a utility concept whereby a farm firm attempted to maximise a utility function, that included other components with profits, subject to some minimum profits constraint. In specifying this profits constraint, Stanbridge introduced the notion of a finance function as,

> 'that administrative area or set of administrative functions in an organisation which have to do with the management of cash, so that the organisation will have the means to carry out its objectives as satisfactorily as possible and at the same time meet its obligations as they become due.'[9]

This finance function thus aimed at achieving the most efficient utilisation of funds, given the firm's goals and decision methods. In the short-term it aimed to control the working capital position and maintain liquidity. In the long-term, it aimed to establish the optimum (in the light of the firm's goals and decision-making procedures) stock and utilisation of capital assets.

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8 Simon (1959), op. cit.

9 Stanbridge (1972), p.34.

It was in the context of the finance function that Stanbridge implied the need to study the investment decision, since this decision implied the need for finance. Stanbridge suggested factors affecting farm firms investment decisions, including:

(a) expections of long-term profits and/or growth;
(b) profits over recent time periods;
(c) current stock of capital;
(d) the availability of internal and external funds
(e) the attitude of the entrepeneur towards risk.

Stanbridge did not derive or test any specific hypotheses of investment behaviour in his study. The lesson from his discussion, however, was that the investment decision ought not be considered outside of other farm-firm decision areas. Investment may arise as the result of maximising some objectives other than profits. Investment may at any one time be constrained because other non-economic objectives have priority and/or available funds are being directed towards other objectives.

Zwart and Laing (1983) have developed this behavioural theory in a New Zealand context. They considered the farmer as a portfolio manager who attempted to maximise his utility through the balance of a wide range of farm and non-farm assets which compete for available income and equity.

2.8 Conclusion

The literature review has served to orient the nature of the problem outlined in Chapter 1. Net investment has been shown to be a difficult variable to measure. Those studies reviewed in this chapter that attempted to explain net investment decision-making, obtained a series of net investment by subtracting from gross investment that amount considered as replacement investment. This procedure was undertaken because gross investment was generally the only variable directly measurable. It is considered that a direct measurement of net investment expenditure would considerably enhance this study of farmer's net investment behaviour.

It is apparent that there is no generally accepted theory of investment decision-making. Until the publication of Zwart and Laing's (1983) work, the models developed in the Australian studies began to link seemingly conflicting theories of farm investment decision-making. These studies proposed the accelerator and neoclassical hypotheses as determining the level of desired capital stock. Liquidity variables were hypothesised to influence the rate of adjustment of actual capital stock to the desired level. The flexible accelerator model provided the empirical mechanism by which these two problems were solved.

The behavioural approach to investment decision-making on New Zealand farms, developed by Stanbridge (1972) and later by Zwart and Laing (1983), upsets this comfortable model described above. In the behavioural approach, the investment decisions cannot be seen as isolated from other goals the farmer may have. The behavioural approach suggests different explanations for funds availability for investment and provides a rationale for the failure of the market rate of interest to explain investment.

Chapter Three

A Review of Selected Empirical Studies on Farm Investment Decision Making

3.1 Campbell's Study

Campbell (1958), when reviewing developments into Australian agricultural investment research, claimed that traditional models of investment had very little relevance to agriculture. Campbell claimed that much capital formation in agriculture was achieved through the direct physical efforts of farmers and their families and consequently required little financing. Internal liquidity, according to Campbell, was of prime importance in capital formation in agriculture. He considered that the most plausible formulation would treat investment as a residual, defined as net income realised from current operations less commitments for taxation and living expenses. His observation was that farmers' consumption expenditure was comparatively unresponsive in the short-run to farm income fluctuations, yet when prices improved markedly farmers quickly adopted a back-log of new technology developed in earlier years. Campbell explained this by distinguishing between transitory and permanent components of income. Transitory components he suggested, were likely to result in sudden shifts in the demand for particular capital inputs.

3.2 Girao's et al study

A number of studies have supported Campbell's contention. Girao et al (1974) investigated the effects of income stability on farmer's investment and included a transitory income variable in his formulation.

Girao et al hypothesised the observed level of capital stock as:

$$K = g\ (K^{*},\ TS^{*},\ F^{*}) \qquad (3.1)$$

where: K = observed capital stock

K^{*} = desired level of capital stock

TS^{*} = expected level of total sales

F^* = expected level of financial conditions

Each expectation was assumed to be a weighted sum of past levels using geometrically declining weights, except TS which had a double lag. Performing a Koyck transformation, defining investment as $IN_t = K_{t+1} - K_t$, and assuming replacement investment was proportional to the existing capital stock $(IR_t = \delta K_t)$ a function for gross investment was hypothesised as:

$$GI_t = (IR_t + IN_t) = a_o (1-\lambda) + a_1 TS_t + a_2 TS_{t-1}$$

$$- (1-\lambda + a_3 - \delta) K_t + a_4 F_{t-1} \qquad (3.2)$$

Because the variables TS_t and TS_{t-1} were highly correlated and the coefficient of TS_{t-1} was never significantly different from zero, a variable, $TS_t - TS_{t-1}$, was used. This variable implied an accelerator mechanism so an alternative formulation replaced this variable by the change in sales from the previous peak level $(TS_t - TS_{max})$. Also, K_t was replaced by the average of K_t and K_{t-1}, implying an alternate one and a half year lag.

Several variables were considered to represent expected financial conditions. These included the level of debt at the beginning of each year, the debt-asset ratio, lagged saving, S_{t-1}, and a variable giving the difference between gross disposable income and expenditure on the consumption of non-durables and services. A transitory income variable was also tested. This was defined as:

$$(\Delta Y_{t-1} - \overline{\Delta Y}) \qquad (3.3)$$

where: $\Delta Y_{t-1} = Y_{t-1} - Y_{t-2}$

Y_{t-i} = net farm income in year t-i

$\overline{\Delta Y}$ was undefined but assumed to be a mean change in net income.

Girao et al tested this model using records of 50 Minnesota farmers for seven years, 1963-1969. Farms' incomes were classified as stable if they had a dairy enterprise and unstable if they did not have a dairy enterprise. Their empirical results for gross fixed investmentare presented in Table 3.1 below.

When considering the sequence of alternative internal fund variables, S_{t-1}, SP_{t-1}, $\Delta Y_{t-1} - \overline{\Delta Y}$, Girao et al noticed the level of explanation to increase for the unstable group while the reverse was true for the stable group. Thus for farmers with unstable incomes, the transitory component of income proved a better proxy for financial conditions than savings; the reverse holding for farmers with stable incomes.

The variables measuring the internal availability of funds were not the only important regressors. In this respect the results were consistent with a pure residual funds hypothesis of capital accumulation as advanced by Campbell (1958).

Girao et al claimed the results were consistent with both a capital stock adjustment mechanism and an availability of funds effect.

3.3 Waugh's Study

Waugh (1977), extended the results of Girao et al through the empirical testing of his investment model. Waugh hypothesised a flexible accelerator investment function:

$$K_t - K_{t-1} = I_t = \beta\,(K_t^* - K_{t-1}) \qquad (3.4)$$

$(0 < \beta \leqslant 1)$

where: K_t = actual capital stock in year t

I_t = net fixed investment in year t

K_t^* = desired capital stock in year t

β = coefficient of adjustment between actual and desired capital stock

Table 3.1: Estimated Coefficients for Gross Fixed Investment - Girao

Method of Estimation	Constant	$TS-TS_{-1}$	$TS-TS_{max}$	$\frac{K-K_{-1}}{2}$	K	S_{-1}	$\Delta Y_{-1} - \Delta Y$	D	R^2
				Unstable Group					
OLS	1.082	0.142			0.215	0.142		-0.048	0.30
	(1.037)[a]	(2.540)			(5.144)	(2.089)		(2,092)	
GLS	2.293	0.142			0.230	0.155		-0.092	0.30
	(1.474)	(2.661)			(3.871)	(2.028)		(3.142)	
OLS	1.894	0.154			0.244		0.138	-0.059	0.31
	(1.996)	(2.806)			(6.190)		(2.585)	(2.717)	
GLS	3.138	0.151			0.263		0.131	-0.104	0.31
	(2.152)	(2.867)			(4.594)		(2.622)	(3.695)	
				Stable Group					
OLS	0.377		0.354	0.117		0.404			0.32
	(0.450)		(3.361)	(4.014)		(3.132)			
GLS	5.057		0.268	-0.133		0.565			0.32
	(1.746)		(2.516)	(1.878)		(3.714)			
OLS	1.503		0.365	0.154			0.252		0.29
	(1.968)		)3.398)	(5.711)			(2.333)		
GLS	6.866		0.232	-0.090			0.214		0.29
	(2.320)		(2.115)	(1.242)			(2.170)		

a Numbers in parentheses are ratios of regression coefficients to their standard errors.
Source - Girao et al (1974), p.147.

Waugh further hypothesised the speed of adjustment, to be a linear function of internal liquidity relative to desired investment, such as;

$$\beta_t = \beta_1 + \frac{\beta_2 Y_{t-1}}{(K_t^* - K_{t-1})} \qquad (3.5)$$

where: β_1 and β_2 = constants to be determined
Y_{t-1} = level of internal liquidity in the previous period

By substituting equation (3.5) into (3.4) the model was written as;

$$I_t = \beta_1 (K_t^* - K_{t-1}) + \beta_2 Y_{t-1} \qquad (3.6)$$

Waugh hypothesised two additional variables as influencing farmers liquidity; the current level of real debt and transitory income. The transitory income variable was defined as:

$$(\Delta Y_t - \overline{\Delta Y}) \qquad (3.7)$$

where: $\Delta Y_t = Y_t - Y_{t-1}$, the real change in net cash income from one period to the next, and
$\overline{\Delta Y}$ = average change in real net cash income over the sample period

Desired capital stock was hypothesised as a function of expected long-term output and relative prices. Deflated gross farm receipts were employed as a measure of output. Two alternative formulations of relative prices were used. One, the relative price of capital to output, was defined as;

$$\frac{P_k (d + r)}{P_o} \qquad (3.8)$$

where: $P_k d$ = depreciation cost of a unit of capital
$P_k r$ = interest cost of having funds invested in a unit of capital
P_o = output price

The alternative formulation was the relative price of capital and labour, defined as:

$$\frac{W}{P_k\ (d + r)} \qquad (3.9)$$

where: W = money wages

Waugh applied this investment model to a cross-section of 23 Australian sheep farm observations covering the years 1967/68 to 1972/73. A technique to explore the individual variations in farm investment behaviour unexplained by the above variables using dummy variables, was employed. The cross-sectional time series model incorporating these dummy variables for individual, between-farm effects was written as;

$$I_{it} = \alpha_1 + \sum_{j=2}^{23} \alpha_j\ DV_j + \beta_1\ (K_{it}{}^* - K_{it-1})$$
$$+ \beta_2 Y_{it-1} + \beta_3 \Delta D_t + U_{it} \qquad (3.10)$$

where: DV_j = $\begin{cases} 1 \text{ for } j = i \\ 0 \text{ otherwise} \end{cases}$

α_1 = the intercept in the regression for farm 1

$\alpha_1 + \alpha_j$ = intercept for farm j, j = 2 ..., 23

U_{it} = error term associated with farm i in year t

Desired capital stock was estimated as a function of real output and the real price of capital in the current year and the previous three years; thus,

$$K_{it}{}^* = \gamma_o + \gamma_1 O_{it} + \gamma_2\ O_{it-1} + \gamma_3\ O_{it-2} + \gamma_4\ O_{it-3})$$
$$+ \gamma_5\ P_{it} + \gamma_6\ P_{it-1} + \gamma_7\ P_{it-2} + \gamma_8\ P_{it-3} +$$
$$U_{it} \qquad (3.11)$$

where: O_{it} = deflated gross farm sales on farm i

P_{it} = real price of capital on farm i

Table 3.2: Estimated coefficients for Net Fixed Investment - Waugh

Capital Stock Determinants		Equation 1	Equation 2
	$\beta_1 \gamma_1 O_{it-1}$	1.69** (0.32)	0.83** (0.29)
Real Output	$\beta_1 \gamma_2 O_{it-2}$	0.98** (0.25)	1.85** (0.29)
	$\beta_1 \gamma_3 O_{it-3}$	0.87** (0.23)	0.76** (0.28)
	$\beta_1 \gamma_5 \left(\frac{P_k(d+r)}{P_o}\right)_{it}$	-192.38 (219.78)	-186.85 (278.68)
Adjustment Rate Determinants			
Real Net Cash Income	$\beta_2 Y_{t-1}$	-2.29** (0.44)	
Transitory Income	$\beta_3 Y_t^*$		0.23* (0.15)
Change in debt	$\beta_3 \Delta D_t$	0.19 (0.16)	
Lagged Capital	$-\beta_1 K_{t-1}$	-1.83** (0.36)	-0.62** (0.07)
R^2		0.78	0.63

Note: Standard error in parentheses

** denotes coefficient significance at 1% level of probability

* denotes coefficient significance at 10% level of probability

Source - Waugh (1977), p.157

Multicollinearity between real transitory income and real debt, ΔD_t, was found on empirical analysis. To overcome this problem, a combined variable was defined as;

$$Y_t^{*} = (\Delta Y_t + \overline{\Delta Y}) + \Delta D_t$$

The regression results are presented in Table 3.2 Waugh summed the individual adjustment coefficients to obtain an overall adjustment coefficient of -0.27. This was defined as the rate of adjustment whenever available funds approximated desired investment. The negative sign on the coefficient suggested to Waugh that even if available cash funds approximated desired investment during the period examined, net investment would be curtailed. Waugh claimed this result concurred with actual investment behaviour over this period.

The estimated transitory income coefficient was of a similar size to that obtained by Girao et al. This suggested that about 20 cents of each dollar of transitory income was spent on investment. This result lent considerable support to the residual funds hypothesis of Campbell, particularly in this model formulation of internal finance having a 'timing' role.

3.4 Johnson's Study

Johnson (1969), observed from incremental capital/output ratios of the New Zealand agricultural sector from 1945 to 1967 that capital expenditure was relatively unproductive in the 1950s compared to the 1960s. This, Johnson believed, reflected post-war shortages and high liquidity in the 1950s and the stocking revolution in the 1960s. Johnson also observed a certain amount of fluctuation in net and gross investment over the same period. He advanced the hypothesis that farmers have at any one time some notion of normal or expected income from farming that they adjusted upwards or downwards as current expectations changed. He considered that expected output prices, the price of capital, time preference rates and availability of investible funds could influence the change in expectations. Ignoring the price of capital, availability of funds and explicit recognition of time preference rates, Johnson supposed expected income to be a weighted average of incomes in recent past periods of production. This relationship was expressed as;

$$I_t = a + b\, Y_t^* \qquad (3.12)$$

where: I_t = net investment in period t
Y_t^* = expected income
a = other demands on net income
b = the propensity to invest

Expected income was expressed as a weighted average of net income to the capital factor for the four preceding production periods;

$$Y_t^* = \frac{[\alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \alpha_3 Y_{t-3} + \alpha_4 Y_{t-4}]}{(\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4)} \qquad (3.13)$$

Substituting expression (3.13) into equation (3.12) the lagged estimating equation was obtained as;

$$I_t = a + b_1 Y_{t-1} + b_2 Y_{t-2} + b_3 Y_{t-3} + b_4 Y_{t-4} + u_t \qquad (3.14)$$

where: $b_1 = \dfrac{\alpha_1 b}{\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4}$ and so on

Testing of this hypothesis was carried out in current prices for aggregate investment in equipment, buildings, improvements and livestock. Some results are presented in Table 3.3.

Table 3.3: Estimated coefficients for aggregate investment in New Zealand agriculture - Johnson

Coefficient	Gross Investment in Equipment Buildings Improvements	Net Investment in Equipment Buildings Improvements	Net Investment in Equipment Buildings Improvements and Livestock
a	-9.27	-4.51	-18.98
b_1	0.248 (0.053)	0.139 (0.036)	0.404 (0.091)
b_2	0.085 (0.056)	0.080 (0.038)	0.007 (0.098)
b_3	0.045 (0.054)	0.007 (0.037)	0.128 (0.094)
b_4	-0.073 (0.049)	-0.036 (0.033)	-0.259 (0.085)
R^2	0.971	0.956	0.908
D.W.	0.75	1.27	1.87

Note: Standard error in parentheses

Source - Johnson (1978)

Gross and net investment fluctuated closely with net farm income lagged one year, and was influenced to a much lesser extent by earlier income levels.

Johnson suggested that farmers took up to two seasons into account in formulating expectations, but no more.

The propensity to invest in gross investment approximated 0.3. That is, for three dollars of increased income, gross investment increased one dollar. Johnson stressed that this took no account of the financing of investment. The pattern of net investment was similar to gross investment, the propensity to invest being 0.2.

When livestock was included in the national net investment aggregate, the goodness of fit was lowered.

Johnson concluded that stock retention by farmers followed a pattern of its own with very little weight being placed on income in the past. However, Johnson noted that livestock retention was highly correlated with net income in the same year. The decision to retain livestock for herd expansion was likely therefore to be made in the years when incomes were buoyant, a result not covered in the chosen theoretical model.

In conclusion, Johnson stated that the level of net investment in New Zealand farming was clearly related to the current well-being of farming. Testing of various hypotheses involving the price of capital, the availability of funds and time preference rates did not produce significant results. He therefore considered a closer investigation of plough-back of funds and borrowing was required before more definite conclusions could be made on the funding relationships between net incomes and subsequent investment in the farm business.

3.5 Laing's Study

Borrowing heavily from Waugh (1977), Laing (1982) used a similar model to explain gross investment in land development, buildings and equipment using national capital expenditure data for the New Zealand pastoral sector from 1957 to 1978. His structural equations are reproduced below.

(a) Gross investment in land development

$$GI_L(t) = b_t(L_t^* - (1-\delta)L_{t-1})$$

$$L_t^* = a_o + a_1\,PW_t + a_2\,PB_t + a_3\,PD_t$$

$$b_t = b_o + b_1\left[\frac{Y_t}{(L_t^*-(1-\delta)L_{t-1})}\right] + b_2\left[\frac{D_t}{(L_t^*-(1-\delta)L_{t-1})}\right] \qquad (3.15)$$

where: $GI_L(t)$ = gross investment in land development in period t

L_t^* = desired stock of land in period t

L_{t-1} = actual stock of land in period t

b_t = adjustment coefficient for land development in period t

δ = replacement rate for developed land

PW_t = average auction price for wool (c/kg)

PB_t = schedule price for prime beef (c/kg)

PD_t = milkfat price (c/kg)

Y_t = gross farm income in period t (\$)

D_t = change in debt per farm in period t (\$)

Unlike Waugh, Laing omitted a variable representing output as a determinant of desired capital stock. Laing's rationale was that land development did not occur in response to increases in livestock numbers or productivity. Rather, stock increases occurred after new land had been cleared and developed into pasture. Prices were included as variables representing the profitability of enterprises. A variable representing the cost of capital services was omitted because land development expenditure was claimed to be indistinguishable from working expenditure, so such a variable could not be computed. Variables determining the adjustment rate coefficient were the same as Waugh's.

(b) Gross investment in buildings:

$$GI_B = b_t \, (B_t^* - (1-\delta)\, B_{t-1})$$

$$B_t^* = a_o + a_1 \, SU_t + a_2 \, \frac{PW}{PC_B}t + a_3 \, \frac{PD}{PC_B}t + a_4 \, \frac{PC_B}{PL}t$$

$$b_t = b_o + b_1 \left[\frac{Y_t}{B_t^*-(1-\delta)B_{t-1}}\right] + b_2 \left[\frac{D_t}{B_t^*-(1-\delta)B_{t-1}}\right] \quad (3.16)$$

where: GI_B = gross investment in buildings in period t

B_t^* = desired stock of buildings in period t

B_{t-1} = actual stock of buildings in period t

b_t = adjustment coefficient for building investment in period t

δ = buildings depreciation rate

SU_t = total number of stock units in period t

PC_B = index of cost of building capital services in period t

PL_t = farm wage index in period t

Laing argued that livestock numbers affected building capacity thus used total livestock units as a variable determining desired capital stock. Other variables were similar to those by Waugh (1977).

(c) Gross investment in equipment

$$GI_E\ (t) = b_t\ (E_t^* - (1-\delta)\ E_{t-1})$$

$$E_t^* = a_o + a_1 SU_t + a_2\ \frac{PW}{PE_E} t + a_3\ \frac{PD}{PC_E} t + a_4\ \frac{PC_E}{PL}\ t$$

$$b_t = b_o + b_1 \left[\frac{Y_t}{E_t^* - (1-\delta)E_{t-1}}\right] + b_2 \left[\frac{D_t}{E_t^* - (1-\delta)E_{t-1}}\right] \quad (3.17)$$

where: GI_E = gross investment in equipment in period t

E_t^* = desired stock of equipment in period t

E_{t-1} = actual stock of equipment in period t

δ_t = rate of equipment depreciation

b_t = adjustment coefficient for equipment investment in period t

PC_E = index of cost of equipment capital services in period t.

Laing's final regression results are reproduced in Table 3.4 below. The final estimating equations were quite different from their theoretical specifications. The price variables were found to be highly correlated with the income variables. This made the income variable coefficient either insignificant or wrongly signed (negative). A significant level of auto-correlation was found in the estimated equations. First-order differences were taken in an attempt to eliminate this problem.

Because the reported results were quite different from the theoretical specifications it was difficult to extend the empirical analysis to the theoretical models. However, assuming that net liabilities per sheep farm and gross farm incomes determine the adjustment rate coefficient, the sum of their estimated coefficients ought to give an indication of the overall adjustment rate should funds availability approximate desired investment.[1] These calculated overall adjustment coefficients are presented in Table 3.5.

1 Following Waugh (1977), the sum of the individual coefficients give the unconstrained adjustment coefficient.

Table 3.4: Estimated coefficients for Gross Investment in the New Zealand pastoral sector - Laing

(A) LAND DEVELOPMENT

Independent Variable	Estimated Coefficient	T-statistic
$L_{t-1} - L_{t-2}$	-0.08	-1.56
$D_t - D_{t-1}$	0.0016	2.08
$G_t - G_{t-1}$	-14.15	-2.28
$SY_t - SY_{t-1}$	0.0011	3.55
$W_t - W_{t-1}$	-0.17	-1.08

$R^2 = 0.52$ D.W. = 1.71

where: L_t = land stock adjusted for depreciation
D_t = net liabilities per sheep and beef farm
G_t = Government policy dummy variable
SY_t = gross income per sheep and beef farm
W_t = days of soil moisture deficit

(B) BUILDINGS

Independent Variable	Estimated Coefficient	T-statistic
Constant	110.23	2.46
SE_t	0.0071	2.07
SD_t	0.031	0.55
TB_t	0.96	2.39
B_{t-1}	-0.020	-1.20
DY_t	0.00045	1.04
G_t	-22.56	-2.04

$R^2 = 0.26$ D.W. = 1.41

where: SE_t = change in breeding ewe numbers

SD_t = change in dairy cow numbers

TB_t = first year depreciation on buildings

B_{t-1} = lagged building stock adjusted for depreciation

DY_t = gross income per dairy farm

(C) EQUIPMENT

Independent Variable	Estimated Coefficient	T-statistic
Constant	-5.83	-0.19
TM_t	0.93	1.70
SB_t	0.067	1.60
E_{t-1}	-0.090	-2.51
SY_t	0.0021	4.19
DY_t	0.0052	12.80
G_t	-15.84	-1.79

$R^2 = 0.94$ D.W. = 1.71

where: TM_t = first year depreciation of equipment

SB_t = change in breeding cow numbers

E_{t-1} = lagged equipment stock

Source - Laing (1982)

Table 3.5: Adjustment Coefficients calculated from Laing (1982)

Investment Input	Lagged Stock		Estimated Coefficients Sheep Income		Dairy Income		Net Liabilities		Final Adjustment Coefficient
	$\lvert b_o \rvert$	+	b_1	+	b_2	+	b_3	=	b_t
Land Development	0.08	+	0.0011	+	0	+	0.0016	=	0.0827
Buildings	0.02	+	0	+	0.00045	+	0	=	0.0204
Equipment	0.09	+	0.0021	+	0.0052	+	0	=	0.0973

These final adjustment coefficients suggest that should available funds approximate the amount required for investment, adjustment would be between two and ten percent of desired investment each period.

3.6 Evans' and Morgan's Study

Evans and Morgan (1982) assumed a farmer's investment decisions were made with the objective of maximising post-tax income, discounted over some finite planning horizon. They derived the magnitude of the marginal value product of capital which would yield a capital unit's optimal inter-temporal use. This they termed the service price of capital. In a subsequent study, Morgan and Evans (1982), derived estimates of the service prices of livestock, farmland, farmland improvements, equipment and buildings for the period 1960 to 1981. The service prices for farmland improvements, buildings and equipment are presented in Appendix 4.

Along with the objective of maximising post-tax returns, the calculations of these service prices included a consideration of the tax rates, depreciation and investment allowances, and concessional finance. The low service prices of farmland development were partly due to the full tax deductibility of farmland development expenditure, particularly over the 1970s. The service price for building remained fairly stable over the data period, falling in the mid-70s with the introduction of first year depreciation allowances. The service price for equipment increased over the data period partly caused by increases in the capital price of equipment.

The service prices measured the increase in marginal value product per period required for an investment in a unit of capital in order to recover the cost of the investment. The low service prices suggested to Morgan and Evans that the marginal value product requirements from investment did not have to be very high for farm investment to be a better alternative than other uses of the funds.

3.7 Zwart's and Laing's study

Zwart and Laing (1983) viewed the farmer as attempting to maximise his utility by balancing his portfolio of farm and non-farm assets which compete for available income and equity. Investment in alternative assets was hypothesised to have different effects on a producers utility, net worth, farm profit and output.

The farmer's utility was a function of both the level of consumption and wealth, expressed as;

$$U = U(C_t, W_t) \tag{3.18}$$

where: C_t = the level of consumption expenditure
W_t = a measure of the farmer's wealth or equity

The farmer's choice of assets and inputs was constrained by a production function which determined the level of output, (Y_t), expressed as;

$$Y_t = f(X_t, V_{it}) \tag{3.19}$$

where: X_t = the level of inputs in period t
V_{it} = the level of the ith asset in period t

In Zwart and Laing's model, the existence of credit rationing and the lack of a perfect capital market were postulated as further constraining the farmer's production decisions. This constraint on debt was expressed as,

$$D_t = B . W_t \tag{3.20}$$

where: D_t = the level of debt in year t
B = a coefficient reflecting the maximum leverage rate

The levels of consumption expenditure and wealth were measured from accounting identities. Wealth was measured from the balance sheet equation as the value of assets less outstanding debt,

$$W_t = \sum_i P_{it} . V_{it} - D_t \tag{3.21}$$

where: P_{it} = value of asset i in period t

Consumption in any period was measured from the cash flow as,

$$C_t = (P_t^{\,y}.Y_t) + D_t - (P_t^{\,x}.X_t)$$

$$- (P_t^{\,d}. D_t) - (\sum_i P_{it}^{\,v} . V_{it}) \tag{3.22}$$

where: P^y, P^x, P^d, P^v = prices associated with output, inputs, debt and assets in period t, and all other variables defined as above.

The simultaneous solution of the first-order conditions of the static model provided the optimal levels of each asset, current inputs and debt.

The short, medium and long term elasticities from Zwart and Laing's results are presented in Table 3.6. These results were obtained from aggregate New Zealand data. The changing levels of the elasticities indicated the different nature of investments.

The changes in consumption, off-farm investment and farm purchase were seen to be short-term in nature and to diminish over time. These categories of investment were seen to be particularly responsive to changes in income levels and possible substitutes for one another.

The response in building and land developments appeared to be slow, particularly land development whose response did not peak after six years. Zwart and Laing postulated that these investments could be complementary as a part of overall farm investment.

Investment in plant and machinery had the greatest response in the second year, to fall away in later years. This reflected the short-term nature of investment in plant, in contrast to land development and buildings.

Increases in income led to a reduction in debt levels. Debt was expected to increase in response to increases in all other assets due to the finance function. The results showed that the maximum response in debt repayment came in the third year, somewhere between the assets which respond in the short-term and the long-term.

Table 3.6: Impact of a single year increase (10%) in Income on asset levels in subsequent years - Zwart and Laing

Change in level of:	Percentage Change		
	Initial Year	Year 3	Year 6
Consumption	2.1	.41	.13
Off-farm investment	.51	.28	-0.9
No. of farm purchases	14.0	-.31	1.20
Building investment	.09	.25	.25
Plant investment	.02	.18	-.04
Land Development investment	.08	.13	.26
Debt	-.14	-.31	-.21

3.8 Conclusion

Prior to the publication of Zwart and Laing's (1982) results, empirical research into farm investment decision making had closely followed theoretical developments. No generally accepted theory of farm investment decision making had been agreed upon, although the stock adjustment model was being used to explain the influence of internal liquidity on the changed demand for capital.

Both Johnson (1979) and Laing (1982) showed the strong relationship that existed between investment and past net incomes in the New Zealand pastoral sector. Their empirical results, however, failed to indicate precisely what component of net income influenced the farmer's state of well being and what influenced availability of funds for investment. The funding relationship between investible funds from income and subsequent investment in the farm business was not made clear. This study could further define this funding relationship.

The behavioural approach developed by Zwart and Laing (1982) put additional dimensions to farm investment decision making. Their results indicate farm investment decision making cannot be seen in isolation to other goals the farmer may have.

For the purposes of this study, however, it is intended to extend the model developed by Waugh (1977). It provides a logical extension to the work by Johnson (1979) and Laing (1982). By studying individual farms, the funding relationship between available funds and investment can more exactly be explored. This ought to overcome the problems inherent in national data in measuring this relationship and which was a limitation in Johnson and Laing's work.

The hypotheses advanced are;

(a) that farmers have some notion of desired capital stock;

(b) that the level of desired capital stock is some function of expected output and the real price of capital;

(c) that liquidity variables influence the rate of adjustment of actual capital stock to the desired level;

(d) that the speed of adjustment is a linear function of internal liquidity relative to desired investment.

The objectives of this study are therefore;

(a) To determine if the investment decisions on New Zealand farms can be incorporated in two dimensions, namely, the determination of desired capital stock and a description of a rate of adjustment to the desired level of capital stock;

(b) To quantify these relationships and their relevance to policy makers.

Chapter Four

Compilation of the Data Base

4.1 Introduction

Empirical testing of the hypotheses explaining investment decision making advanced in the conclusion to Chapter 3 required the collection of data series comprising actual levels of capital stock, net investment, some pressure-on- capacity variables, the price of capital, and liquidity variables. It was also considered desirable to obtain a direct estimate of net investment. This chapter describes the data collection process.

The data base chosen was the farm records of a set of 21 sheep and beef farms that were surveyed by the New Zealand Meat and Wool Board's Economic Service (MWBES) each year from 1973/74 to 1980/81. These farms contributed to the MWBES Sheep and Beef Farm Survey over that period. Although these 21 farms were among that set of farms randomly selected for the Sheep and Beef Farm Survey, the sample chosen for this study was selected from this set on the basis of the maximum number of farms for the longest possible period for which data was continuously gathered. The farms chosen belonged to the Hill or Hard Hill Country farm class in the Wairarapa and West Coast North Island regions. Farmers in these farm classes and regions were chosen because of their proximity to Massey University.

4.2 Measurement of capital stock

Section 2.2.2 of Chapter 2 introduced the identity by which a capital stock and net investment series was commonly obtained. This was;

$$K_{t+1} = K_t - d_t + GI_t \qquad (4.1)$$

where: K_{t+1} = capital stock in year t+ 1
K_t = capital stock in year t
d_t = depreciation of capital stock in year t

GI_t = gross investment in year t

Because gross investment was a more easily measurable variable than net investment, a time series of actual capital stock and net investment could be built up from a base year valuation of capital stock, and a time series of gross investment observations, together with assumptions on the rate of depreciation and the rate of replacement investment.

Some difficulties in measuring capital stock were also discussed in Section 2.2.2. These difficulties largely involved measurement of the rate of depreciation of capital stock. The value of an asset ought formally to be the asset's net present value discounted at an appropriate rate of interest. The only precise expression of an asset's present value is what the market is prepared to pay for an asset. Unfortunately, for most farm assets no second-hand market exists, hence no way of measuring the rate of depreciation.

The MWBES had previously computed for their own purposes a variable representing the current market value of each farm in their survey as a going concern. This variable was computed by the MWBES as the sum of the market values of land and improvements, sheep and cattle, and the book value of equipment. Use of this variable negated the need to build up a capital stock series using identity (4.1). Such a variable explicitly included depreciation of capital stock and expenditure on capital replacement.

It is recognised that there may be measurement errors in this value of capital stock. Because of accelerated investment and depreciation allowances, the value of equipment may be less than the value of the services they embody. However, it is likely that such investment and depreciation allowances result in a reduced value of second-hand farm equipment. The market valuations of land and improvements, and livestock were subjective assessments at the time by MWBES Field Officers. Such valuations may not truly reflect the value of their productive services. However, to the extent that they are made by the same officer, such valuations have the benefit of consistent bias between farms.

4.3 Measurement of net investment

In identity (4.1), net investment was obtained by subtracting from gross investment that portion considered as replacement investment. Generally this required an assumption that the rate of replacement investment be the same as the rate of depreciation.[1] Regardless of the rate used for replacement investment, any assumptions made could not be accepted as fact and would place at risk the accurate measurement of net investment. Investigation of the replacement investment decision process was beyond the scope of this study. A more direct measurement of net investment was therefore required.

A close inspection of some farm accounts held by the MWBES revealed that the Field Officers kept a written record that described net investment incurred in each year. Although these records were not tabulated on the MWBES computer data base, a series of net investment data could be obtained by tabulating the written record with the dollar amounts expressed in the farm accounts. This analysis was undertaken with the assistance of the Field Officers' knowledge of each farmer's situation where necessary.

As was to be expected, the various forms of organisation of farm accounts confused the real allocation of cash, depending upon the individual circumstances of the farmer. Net investment could be recorded in the Farm Working Account, the Field Assets Register or in the Balance Sheet. To ensure that an accurate record of net investment

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1 Jorgenson (1971) devoted considerable discussion to this topic

was obtained, the full cash flow generated by each farm each year was reconstructed. This process ensured that all cash flows each year had been accounted for. The cash flow format, which also enabled a precise measure of the individual farmer's liquidity, is described in the next section.

4.4 A description of cash flow format

The cash flow format provided a means of tracing all cash flows in the farm accounts. The basis of the cash flow was the balance sheet equation:

$$A_t = L_t + OE_{t-1} + (R-E)_t \tag{4.2}$$

where: A_t = assets at the end of year t
L_t = liabilities at the end of year t
OE_{t-1} = owner's equity at beginning of year t
R_t = revenue in year t
E_t = expenditure in year t

Assets and liabilities could be considered as either short-term or long-term, thus:

$$CA_t + FA_t = CL_t + TL_t + OE_{t-1} + (R-E)_t \tag{4.3}$$

where: CA_t = current assets (short-term)

FA_t = fixed assets (long-term)

CL_t = current liabilities (short-term)

TL_t = term liabilities (long-term)

The balance sheet equation can also be expressed in terms of changes, as;[2]

$$\Delta CA_t - \Delta CL_t = \Delta TL_t - \Delta FA_t + (R-E)_t \qquad (4.4)$$

where: ΔCA = change in current assets

ΔCL = change in current liabilities

ΔTL = change in term liabilities (i.e. borrowing/repayment)

ΔFA = change in fixed assets (i.e. gross investment)

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2 Proof: the balance sheet equation in year t and year t-1 are:

$CA_t + FA_t = CL_t + TL_t + OE_{t-1} + (R-E)_t$,

$CA_{t-1} + FA_{t-1} = CL_{t-1} + TL_{t-1} + OE_{t-2} + (R-E)_{t-1}$.

The change between year t and t-1 therefore is,

$\Delta CA_t - \Delta CL_t = \Delta TL_t - \Delta FA_t + OE_{t-1} - OE_{t-2} + (R-E)_t - (R-E)_{t-1}$

But $OE_{t-1} = OE_{t-2} + (R-E)_{t-1}$

Therefore $OE_{t-1} - OE_{t-2} - (R-E)_{t-1} = 0$

Therefore $\Delta CA_t - \Delta CL_t = \Delta TL_t - \Delta FA_t + (R-E)_t$

Table 4.1: Illustration of cash flow measurement : farm 1 in 1973/74

Item Description	Cash Outflow		Cash Inflow	Balance
Total Farm Cash Receipts			32,334	
Farm Cash Operating costs	16,738			
Net Farm Cash Income				15,606
Other cash inflows				
Term borrowing			0	
Off-farm income			0	
Income equalisation			0	
(A) Total Cash Inflow				15,606
Net Investment				
Land Development	0)			
Farm Improvements	237)	1,165		
Building Additions	0)			
Land Additions	0)			
Equipment Additions	928)			
Replacement Investment				
Plant and Vehicle Replacement	2,303)			
Building Replacement	0)	5,140		
Fertiliser	2,102)			
Farm Improvement Replacement	735)			
Personal Expenditure				
Drawings	2,277)			
Tax	0)			
Personal capital	7,821)	10,933		
Term loan repayments	835)			
(B) Total Disposal Expenditure		17,238		
(A) - (B) Cash Balance				-1,632
Made up of:				
Current asset change			-892	
Current liability change			-740	
Total Working Capital Change			-1,632	

This equation thus showed that any change in working capital, ($\Delta CA - \Delta CL$), is equal to the net change in cash flow. The cash flow of Farm 1 in 1973/74 is presented in Table 4.1 as an illustration of the data compilation process and the variables that make up the balance sheet equation.[3]

It can be seen from Table 4.1 that the change in cash balance reconciles with the change in working capital in the balance sheet.

4.5 Definition of the variables for the investment model

4.5.1 Value of real capital stock per farm

In section 4.2 the value of capital stock per farm was discussed. The variable chosen to represent capital stock was the sum of the market values of land, improvements, and livestock and the book value of equipment. This variable was deflated to 1973/74 terms by the Valuation Department Grazing Land Price Index.[4,5]

4.5.2 Real net investment per farm

Net investment comprised capital additions in five aggregates: land development, land improvements (fencing, water supply, drainage, access), buildings, equipment and land purchase. Each aggregate was deflated to 1973/74 terms by the appropriate capital price index to obtain volume measures.[4] Real net investment was then computed as the sum of these real amounts.

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3 These variables are further defined in Appendix 2.

4 The list of price indices used is presented in Appendix 3

5 No price indices of livestock and equipment stocks were available. Because land comprised over 95% of farm capital stock value, deflation of the three aggregates comprising farm capital stock by the land price index would not have created a large bias.

Care was taken to distinguish between capital expenditure on the farm and on the family. Expenditure on capital items that added to the quality of life of the farm family was considered as one of the fruits of, or an alternative to, investment on the farm. Such expenditure was aggregated into a variable termed personal capital. Personal capital included expenditure on the homestead, the family car and off-farm investment.

4.5.3 Real cash balances per farm

Waugh (1977) used net cash income in the previous year as a measure of farm liquidity, since data limitations prevented him from using any alternative measure. But since it may be disbursed in a number of ways, net cash incomes can be an unreliable measure of the farmer's liquidity at the beginning of each period.

The cash flow format described in section 4.4 enabled a precise expression of the farmer's liquidity. Thus farm liquidity was defined here as the balance of working capital at the end of the previous period. It would be this cash that would be available for net investment in the current period. Cash balance was deflated to 1973/74 terms using a monetary price index to reflect changes in purchasing power.[6]

4.5.4 Real transitory income per farm

It was hypothesised by Campbell (1959) that income variability through time could increase the level of farm investment. Waugh (1977) attempted to capture this behaviour by calculating a variable to represent change in net income that exceeded the expected change.

This study follows on from Waugh by postulating that because of market and climatic fluctuations, farmers hold an expectation of income variability. Expenditure is planned in the light of this expected income variability. Any variation in net income beyond the expected bounds is considered as transitory. Such transitory income is postulated to finance (or discourage) net investment.

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6 4 op cit

Expectations of income variability were assumed to be formed over a considerable period of time. An estimate of these expectations (formed before the data period), was calculated as the mean absolute change in real net cash income on each survey farm over the data period. Transitory income was then calculated as the variation in real net income from this norm, thus;

$$TR_{it} = \Delta Y_{it} - \overline{\Delta Y}_i \text{ when } |\Delta Y_{it}| > \overline{\Delta Y}_i, \text{ for } \Delta Y_{it} > 0$$

$$= \Delta Y_{it} + \overline{\Delta Y}_i \text{ when } |\Delta Y_{it}| > \overline{\Delta Y}_i, \text{ for } \Delta Y_{it} < 0$$

$$= 0 \quad \text{otherwise}$$

where: TR_{it} = transitory income in year t on farm i

ΔY_{it} = $(Y_{it} - Y_{it-1})$, the change in real net income on farm i from year t-1 to year t

$\overline{\Delta Y}_i$ = mean absolute change in real net income on farm i over the data period

Thus when a farmer's income variation is wide, his 'normal' expectation of income change will be wide. The size of transitory income is therefore specific to each farmer and depends on what his 'normal' expectations are.

Net farm income was calculated as farm cash receipts less farm cash operating expenses. Excluded from farm operating expenses were expenditure on replacement of capital assets and fertiliser, both of which were assumed to be discretionary expenditure and not part of normal farm operating costs. Each farm income and expenditure aggregate was deflated to 1973/74 values by the appropriate price index, in order to de-trend output and input price movements.

4.5.5 The real price of capital

The decision rule developed by Jorgenson (1965) in his neoclassical theory of the firm, stated that in each time period the profit maximising firm would select that stock of capital such that the marg inal product of capital equalled the price ratio of the 'cost' of capital to the price of output.

Morgan and Evans (1982) developed the service price of capital, which is analogous to the 'cost' of capital referred to in Jorgenson's theory of the firm.

The service prices were calculated by Morgan and Evans (1982) for a larger set of farms surveyed by the Meat and Wool Board's Economic Service (MWBES) than that set used for this study.[7] It was accepted that these service prices would approximate the cost of capital faced by the farms in this study. Another index calculated by the MWBES, a sheep and beef farms prices received index, was used as an output price index.

In order to collate the many items contributing towards a cost of capital services, it was assumed each farmer formed a single, average, expected cost. This meant that the price of capital services of one capital input did not influence the demand for another. Farmers were assumed to weigh the cost of capital services for each capital input by 'normal' net investment on that input relative to 'normal' net investment. When undertaking net investment, it was assumed farmers considered their own past experiences and those of other farmers. To represent this process, weights were calculated as average net investment on each capital input for the group of survey farms relative to average net investment for the group of survey farms. It was assumed farmers took recent experience in forming these expectations, thus net investment in the previous year was used in the calculation.

Expected real price of capital services was therefore calculated as;

$$PC_t^* = Cm_{t-1} \cdot Po_{t-1}$$

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7 These Service Prices are detailed in Appendix 4. Personal communication with the authors concluded that the data series contained in Morgan and Evans (1982) contained small errors.

where: PC_t^* = expected real price of capital services in year t

Po_{t-1} = Meat and Wool Board's Economic Service Prices Received Index

$$Cm = \sum_{z=1}^{3} [SP_{z_{t-1}} * (I_{z_{t-1}} / I_{t-1})]$$

$SP_{z_{t-1}}$ = the service price of land improvements, equipment and buildings in year t-1

$I_{z_{t-1}}$ = average net investment on land improvements, equipment, building in year t-1

I_{t-1} = average net investment in year t-1

4.6 Conclusion

Having decided to extend the investment model developed by Waugh (1977), a source of data at the individual farm level was required. This data source ideally required sufficient detail to distinguish net from gross investment expenditure and the funding relationship between available funds and net investment.

The chosen data source, farms surveyed by the Meat and Wool Board's Economic Service, proved suitable for the needs of this study. Accuracy of the data was enhanced by the personal knowledge of the sample farmers by the MWBES Field Officers. Consequently, a net investment and capital stock time series was constructed for each of the 21 farms over the eight years and full farm cash flows provided checks on the total flows of cash on each farm. The cash flow also provided unique measures of the farmer's liquidity.

In interpreting the results, it needs to be remembered that the data source suffers from a possible lack of generality. Although the farms studied were taken from a larger set of farms that had been randomly selected for the MWBES Sheep and Beef Farm Survey, a random selection was not drawn for this study.

Chapter Five
A Description of the Survey Farms

5.1 Regional and farm type differences

The location and farm types of the individual farms can be obtained from Table 5.1. Of the 21 farms, eight were from the West Coast, North Island region, (WC), and 13 were from the Wairarapa region (W). Summer rainfall distribution distinguished these two regions - the former described as 'summer moist', the latter as 'summer dry'.

The survey farms were drawn from two farm types. Six of the eight WC farms were described as belonging to the hill country class (H). This class was defined as easy hill country selling a high proportion of lambs in forward store or prime condition.[1] Eight of the 13 Wairarapa farms were described as belonging to the hard hill country class (HH). This class was defined as steep hill country with approximately one-quarter of the farm revenue obtained from the sale of cattle, the balance of the revenue derived from the sale of wool and store sheep and lambs.

5.2 Effective Farm Areas

The effective areas of the survey farms in 1973/74 can be obtained from Table 5.1. This distribution is graphed in Figure 5.1. Sixteen farms were in the farm size interval 651-900 hectares. One farm had an effective farm area in 1973/74 of 1497 hectares. The larger farms were concentrated in the Wairarapa Hard Hill country farm class. This was expected given that these farm systems were more extensive than the Hill Country farm class systems. The remaining two large farms were West Coast farms, one from each farm type. The three farms in the farm size interval 151-250 hectares were hill country farms.

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1 Farm type definitions are from 'Sheep and Beef Farm Survey', Meat and Wool Board's Economic Service, 1980/81, p.8

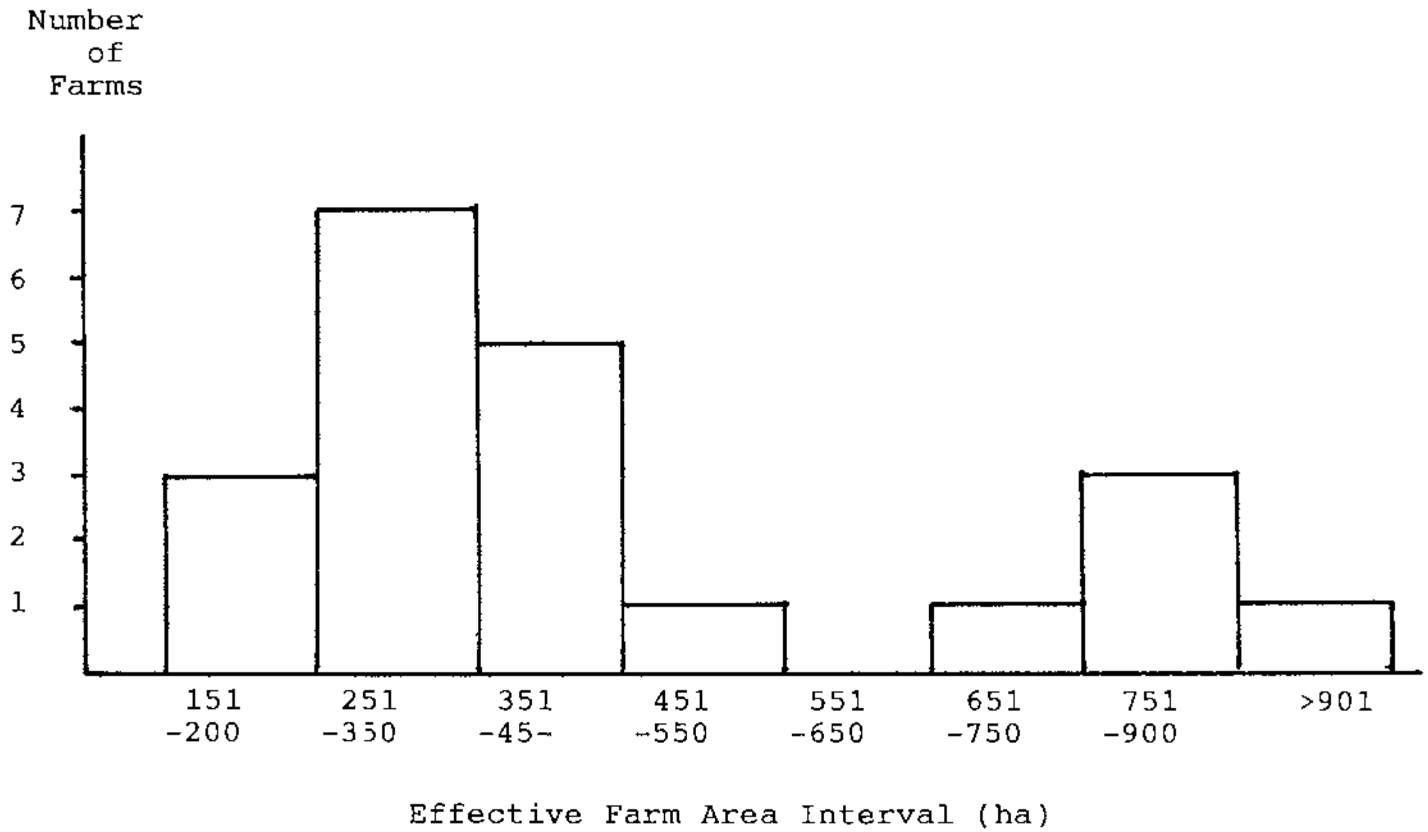

Figure 5.1: 1973/74 effective farm area distribution of survey farms

5.3 Farm capital values per hectare

The capital values per hectare of the individual farms in 1973/74 are indicated in Table 5.1. This value includes all assets that give value to the farm. It includes the value of unimproved farmland and subsequent improvements to the land, including structures. It also reflects off-farm factors that give value, such as distance to town and markets and the state of the local infrastructure.

It was expected that such capital values would given an indication of the relative state of development of each farm, and an indication of the possible investment projects available to the farmer.

The West Coast, Hill Country farms had on average greater capital values per hectare than the farms in other regions and farm types. This would be expected given the more favourable climatic and market conditions that face farmers in this region and farm type. Of this group, four farms had capital values greater than $600/ha in 1973/74 (farms 1, 3, 4, 6). Farm 2 was of intermediate capital value. Farm 5 was of low capital value. The first four were described by the MWBES Field Officers as farms of easy country in a well developed state.[2] Farm 2 was described as easy country but less well developed. Farm 5 was described as easy country but no woolshed, poorly fenced and tracked. It was apparent that the capital values per hectare gave an indication of the relative state of development of this group of farms.

Both West Coast, Hard Hill country farms had about the same capital values per hectare in 1973/74. Farm 7 was described as of moderate to steep contour, in a reasonably well developed state. Farm 8 was described as a small rehabilitation farm, in an isolated area with broken terrain, resulting in difficult internal access. The capital values of these two farms in 1973/74 were only about two-thirds of those of the West Coast Hill Country farms.

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2 A description of each farm is given in Appendix 1

Table 5.1: Physical and Financial Features of the Survey Farms

Farm	Region (a)	Farm Type (b)	Eff. Area (ha) 73/74	% Area Change 73/74 80/81	Farm Value 73/74 ($/ha)	Stocking Rate 73/74 (su/ha)	% Change Total SU 73/74 80/81	Approximate Farmer Age (years) 73/74
1	WC	H	245	0	652	8.9	-31	70
2	WC	H	874	-3.3	452	8.4	25	35
3	WC	H	227	5.7	678	10.6	10	40
4	WC	H	417	3.4	650	12.2	10	45
5	WC	H	365	2.2	370	9.1	21	34
6	WC	H	316	0	630	10.9	17	55
7	WC	HH	659	2.7	410	8.8	23	33
8	WC	HH	265	0	407	8.7	4	50
9	W	H	299	0	422	9.0	6	55
10	W	H	386	0	573	10.6	- 7	55
11	W	H	279	9.0	339	8.2	11	55
12	W	H	175	0	657	9.7	8	70
13	W	H	470	0	609	8.6	25	48
14	W	HH	344	0	383	7.7	27	50
15	W	HH	417	6.2	420	9.0	12	55
16	W	HH	1497	5.7	291	6.4	29	33
17	W	HH	441	6.6	234	5.2	24	40
18	W	HH	830	9.2	414	8.6	- 5	40
19	W	HH	830	0	457	8.2	30	48
20	W	HH	304	3.6	426	8.7	22	55
21	W	HH	310	0	515	8.9	14	44

(a) WC = West Coast North Island
W = Wairarapa

(b) H = Hill
HH = Hard Hill

This could be expected given the less favourable farm type and regional infrastructures that influence the value of the farm. The capital values did not, however, indicate any difference in the level of development of these two farms.

The capital values per hectare of the Wairarapa Hill Country farms were in the same range as their West Coast counterparts. Three farms had capital values greater than \$570 per hectare in 1973/74 (farms 10,12,13). Each of these farms were described as well-developed. Farm 9 was described as in a moderate state of development and a capital value of \$422/ha, Farm 11 was described as being bought back into production from a run down state, as reflected in its valuation of \$339/ha. The capital values per hectare of this group of farms, therefore, appeared to give a reliable indication of their relative states of development.

The Wairarapa Hard Hill country farms had a wide range of capital values per hectare in 1973/74. Farms 19 and 21 had the highest capital values (greater than \$450/ha), and were described as old family farms in a good state of development. Farms 14, 15, 18 and 20 had capital values in 1973/74 between \$380 and \$420 per hectare, and were described as moderately developed farms. Farms 16 and 17 had low capital values per hectare (under \$300) and were described as relatively undeveloped farms.

Without any better information to give a contrary view, the group of farms chosen covered a range of states of development, and it appeared that the relative states of development could be approximated by capital values per hectare. Regional differences may, however, have given a premium to the West Coast farms over their Wairarapa counterparts.

5.4: Net Investment expenditure over the period 1973/74 to 1980/81

Table 5.2 describes net investment expenditure undertaken on each survey farm over the data period 1973/74 to 1980/81. The net investment aggregates considered were land development, farm improvements, farm buildings, farm equipment and additional land purchase. The individual farms have been grouped according to high, medium or low capital values or 'initial development states', as described in Section 5.3. Net investment on each farm has been given a subjective value based on the pattern of expenditure observed in the data series. Patterns looked for were:

(a) large, regular expenditure
(b) large, irregular expenditure,
(c) small, regular expenditure
(d) small, irregular expenditure,
(e) no expenditure.

It was expected that such patterns of expenditure would reflect the type of net investment project and the willingness and ability of the farmer to undertake and finance each net investment project. As an indication of the size of net investment on these inputs, Table 5.3 presents average net investment per hectare on each survey farm over the data period.

With the exception of farms 3 and 10, little expenditure on land development occurred on the well-developed farms. This was in contrast to the undeveloped farms, each of which had large, regular expenditure on land development. Most moderately-developed farms had large expenditure on land development, although there was some variation in the regularity of such expenditure. Two developed farms, farm 3 and farm 10, incurred large land development expenditure to the virtual exclusion of net investment on other capital inputs. The undeveloped farms generally had large expenditure on other net capital inputs associated with the land development. Except for farm 2, the moderately developed farms

Table 5.2: Type and Intensity[1] of Real Net Investment on Survey Farms Grouped according to State of Development

Region and Farm Type	Well developed						Moderately Developed						Undeveloped					
	Farm	Land Dev't	Farm Imp's	Build-ings	Equip-ment	Land Purch.	Farm	Land Dev't	Farm Imp's	Build-ings	Equip-ment	Land Purch.	Farm	Land Dev't	Farm Imp's	Build-ings	Equip-ment	Land Purch.
West Coast Hill	1	-	LI	SI	LR	-	2	LR	LR	SR	SR	-	5	LR	LR	LI	LI	LI
	3	LR	SI	-	SI	-												
	4	-	LI	LI	SI	-												
	6	-	LR	LR	LR	LI												
West Coast Hard Hill							7	LI	SR	SI	LI	LI						
							8	SI	SR	-	SI	-						
Wairarapa Hill	10	LI	SI	-	LI	-	9	-	SR	SI	LI	-	11	LR	SR	SI	SR	-
	12	SI	SI	SI	SI	-												
	13	-	LI	SI	LI	-												
Wairarapa Hard Hill	19	-	LR	LI	SI	-	14	LI	SI	SI	LI	-	16	LR	LR	LI	LI	LI
	21	SI	LR	LI	LI	-	15	LR	SR	SI	LI	-	17	LR	LI	-	SI	LI
							18	LI	SI	-	SR	-						
							20	LR	SR	SI	SI	LI						

CODE: LR = large, regular expenditure; SR = small, regular expenditure; LI = large, irregular expenditure; SI = small, irregular expenditure; - = no expenditure

1 The relative volume of net real investment was based on net real investment per hectare on each capital input, supported by records of the nature of net investment projects.

Table 5.3: Average Real Net Investment Expenditure Per Hectare ($ 1973/74) from 1973/74 to 1980/81 on Survey Farms Grouped According to State of Development

Region and Farm Type	Farm	Well Developed					Farm	Moderately Developed					Farm	Undeveloped				
		Land Dev't	Farm Imp's	Build-ings	Equip-ment	Land Purch.		Land Dev't	Farm Imp's	Build-ings	Equip-ment	Land Purch.		Land Dev't	Farm Imp's	Build-ings	Equip-ment	Land Purch.
West Coast Hill	1	0	2.1	0.4	4.4	0	2	0.7	1.8	0.9	1.1	0	5	5.4	7.5	8.0	0.8	1.0
	3	13.2	0.4	0	1.4	0												
	4	0	5.2	0.8	1.0	0												
	6	0	7.5	6.2	5.2	2.0												
West Coast Hard Hill							7	1.3	1.0	0.6	1.8	3.0						
							8	0.4	1.9	0	0.7	0						
Wairarapa Hill	10	1.8	2.0	0	3.4	0	9	0	1.9	0.2	2.0	0	11	4.0	2.4	0.6	0.9	0
	12	0.2	1.2	0.9	0.3	0												
	13	0	2.8	0.4	1.1	0.3												
Wairarapa Hard Hill	19	0	2.8	1.3	0.2	0	14	1.0	0.5	0.3	2.2	0	16	4.3	2.1	0.6	1.6	0.4
	21	0.1	5.6	1.9	1.3	0	15	4.1	1.9	0.8	1.7	0	17	5.9	1.6	0	0.4	0.4
							18	2.0	2.0	0	0.9	0						
							20	4.2	1.4	0.3	0.03	4.5						

had small expenditure on other net capital inputs associated with their land development programmes.

Expenditure on additions to buildings, equipment and land purchase was typically 'lumpy' characterised by large, irregular amounts. Large items of building expenditure occurred only on the well developed and under-developed farms. Large items of expenditure on equipment and land purchase occurred in each farm group. It was only in the well developed, West Coast Hill Country group that large regular expenditures on building and equipment were recorded.

5.5 Changes in stock numbers and effective area from 1973/74 to 1980/81

Table 5.4 lists stocking rates and effective areas on the individual survey farms in 1973/74, together with the percentage changes in these variables betwen 1973/74 and 1980/81. The individual farms have been grouped accordingly to high, medium and low capital values per hectare, or "initial development states" as discussed in Section 5.3. It was expected that the better developed the farm, the greater would be the (potential) stocking rate. It was also expected that any increase in the state of development of a single farm over time was likely to have associated with it an increase in stock numbers and/or effective area. For instance, the less developed farms, by having more potential for development, may have exhibited more change over the data period than the more developed farms.

The farms with the highest and lowest initial stocking rates were located in the well developed and undeveloped groups respectively. There was however considerable variation in initial stocking rates across the groups and within each group.

Inspection of the percentage change in total stock numbers over the data period indicates that some farms may have initially been stocked below their potential. For example, farm 1 in 1973/74 had a stocking rate well

Table 5.4: Stock Numbers and Effective Area Change on Survey Farms Grouped According to State of Development

	Well Developed				Moderately Developed				Undeveloped			
Region and Farm	Farm	SU/HA 73/74	% Change 73/74-80/81 Stock Nos	% Change 73/74-80/81 Eff. Area	Farm	SU/HA 73/74	% Change 73/74-80/81 Stock Nos	% Change 73/74-80/81 Eff. Area	Farm	SU/HA 73/74	% Change 73/74-80/81 Stock Nos	% Change 73/74-80/81 Eff. Area
West	1	8.9	31	0	2	8.4	25	-3.3	5	9.1	21	2.2
Coast	3	10.6	10	5.7								
Hill	4	12.2	10	3.4								
	6	10.9	17	0								
West Coast					7	8.8	23	2.7				
Hard Hill					8	8.7	4	0				
Wairarapa	10	10.6	-7	0	9	9.0	6	0	11	8.2	11	9.0
Hill	12	9.7	8	0								
	13	8.6	25	0								
Wairarapa	19	8.2	30	0	14	7.7	27	0	16	6.4	29	5.7
Hard Hill	21	8.9	14	0	15	9.0	12	6.2	17	5.2	24	6.6
					18	8.6	-5	9.2				
					20	8.7	22	3.6				

below those of farms 3, 4 and 6. A more than proportionate increase in stock numbers over the data period bought closing stock numbers closer to the other similarly-developed farms. This pattern can be observed with farm 13 in the Wairarapa Hill Country class and farms 14, 16, 17 and 19 in the Wairarapa Hard Hill country class.

All the undeveloped farms had large increases in stock numbers and effective areas over the data period. These farms were those whose investment opportunities would have been expected to be the greatest.

5.6 Changes in output from 1973/74 to 1980/81

Table 5.5 lists indices of total farm output per hectare on each survey farm in 1973/74, together with the average annual percentage change in this variable from 1973/74 to 1980/81. This latter variable was calculated to give an indication of the magnitude and trend of change in output. The output index was calculated as total farm receipts per hectare deflated by MWBES prices received index. The average annual percentage change index was calculated as the average annual percentage change in real total farm receipts per hectare. Real dollar values were chosen because individual farms may have produced different valued output. Average annual percentage change was chosen because yearly changes in real total farm receipts per hectare were observed to be subject to fluctuations.

Because product prices from the farmer's point of view are fixed, it was expected that total farm receipts would be directly related to the volume of output. However, if stock numbers increased as a result of additional capital inputs, then output per hectare could increase at variable rates. The rate would depend upon the state of development of the pasture and the type of additional capital input.

Table 5.5 showed total farm receipts per hectare to be greatest on well developed farms. This value was greater on West Coast farms than Wairarapa farms. This could possibly be due to climatic differences. West Coast

Table 5.5: Indices of Total Farm Output Per Hectare on Survey Farms Grouped According to State of Development

	Well Developed TR/HA[1]			Moderately Developed TR/HA			Undeveloped TR/HA		
Region and Farm Type	Farm	$/HA 73/74	Aver. % change[2] 73/74-80/81	Farm	$/HA 73/74	Aver. % change 73/74-80/81	Farm	$/HA 73/74	Aver. % change 73/74-80/81
West Coast Hill	1	132	0.3	2	90	2.6	5	75	7.3
	3	125	0.9						
	4	237	-2.3						
	6	164	0.1						
West Coast Hard Hill				7	131	2.4			
				8	94	0.6			
Wairarapa Hill	10	126	-2.3	9	91	2.6	11	111	1.0
	12	207	-0.6						
	13	113	2.7						
Wairarapa Hard	19	107	2.3	14	59	3.4	16	60	5.1
	21	99	3.7	15	86	-0.3	17	53	5.7
				18	99	-0.4			
				20	91	-0.6			

1. TR/HA = total farm receipts per hectare deflated by MWBES prices received index
2. Aver.% change=average annual percentage change in real total farm receipts per hectare

farms, because of more reliable summer rainfall distribution, may for instance have the opportunity of finishing additional lamb from Wairarapa farms.

Total farm receipts per hectare were generally less with lowered state of development group. Within each state of development group, total receipts per hectare were greatest for those farms with high initial stocking rates.

Changes in real total farm receipts per hectare over the data period were however variable. Each undeveloped farm showed an increased trend in real total receipts per hectare over the data period. Farm 1, 13, 19 and 21 were the only well developed farms with similar trends, as were farms 2, 7, 9 and 14 of the moderately developed group. Several farms showed a decreased trend in real total receipts per hectare over the data period. Three well developed, West Coast Hill country farms, farms 1, 3 and 6, despite large increases in stock units and/or effective farm area over the data period exhibited little change in real total farm receipts.

Comparison of trends in real total receipts per hectare with average real net investment per farm in Table 5.3 indicated that the well developed farms in particular incurred considerable net investment expenditure with little or no gain in output. The exceptions, farm 13, 19 and 21 had lower initial stocking rates than similarly developed farms so may have had the potential to significantly increase output. In the moderately developed farm group, farms 15, 18 and 20, each of which had declining output trends, incurred large net investment expenditure on land development. Farm 7, whose increases in stock numbers and output was high over the data period, incurred large expenditure on each new capital input. In contrast to the well developed farms, the undeveloped farms incurred large net investment expenditure, particularly on land development, and managed large increases in output over the data period.

5.7 Owner ages on the survey farms

The approximate ages of the survey farm owners in 1973/74 can be obtained from Table 5.1. Approximate ages ranged from 33 to 70. Nine of the survey farm owners were older than 55 in 1973/74. Ownership changes to sons occurred on farms 6 and 15 in 1975/76, on farm 9 in 1974/75 and on farm 11 in 1976/77. These three farmers, plus the owners of farms 2, 5, 7, 16 and 17 were aged less than 35 years. These farmers were observed to be incurring large regular expenditure on net investment projects over the data period.

5.8 Summary

This chapter has described the productive capital nature of the farms surveyed. It was found that these farms could be placed in groups of similar initial states of development. This grouping provided the basis for comparing net investment levels and types, levels of output and output change.

Physical differences between farms of different levels of development were observed. These included an increase in stocking rate and output per hectare with increased development state.

Differences in initial development states appeared to influence the nature and level of the net investment inputs. Land development in particular was concentrated on the less developed farms. Net investment on farm improvements and buildings was larger and more sustained on well developed farms than on undeveloped farms. New equipment purchase was large and irregular in timing over all farms.

Output changes on the survey farms were variable over the data period. Farms whose initial stocking rates were below those on other similarly-developed farms were found to have a more than proportionate increase in stock numbers. These farms typically undertook regular expenditure on farm improvements and showed increased positive trends in output over the data period. Many of the well developed farms undertook considerable net investment expenditure with little or no increase in output. A similar situation was observed on those moderately developed farms who concentrated net investment expenditure on land development. Each undeveloped farm by contrast yielded large increases in output over the data period while incurring large expenditure on net investment.

Chapter Six

The Regression Results and Their Interpretation

6.1 Introduction

The theoretical and empirical studies reviewed in Chapters 2 and 3 oriented this study to an extension of the investment model developed by Waugh (1977). The specific hypotheses advanced by Waugh provided a logical extension to recent work by Johnson (1979) and Laing (1982) in the investment decisions of New Zealand farmers. This chapter modifies the relationships developed by Waugh in the light of the survey farm characteristics described in Chapter 5 and then quantifies these relationships.

6.2 An initial specification of a model of investment behaviour

It was assumed that New Zealand farmers aspired to a long term level of capital stock, expressed algebraically as:

$$I_{it} = b_{it} (K_{it}^{*} - K_{it-1}) \qquad (6.1)$$

where: I_{it} = net investment on farm i in year t

K_{it}^{*} = desired capital stock on farm i in year t

K_{it-1} = actual level of capital stock in year t-1

b_{it} = the partial coefficient of adjustment between actual and desired capital stock[1]

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1 The literature review of Chapter 2 constrained b to be a value between zero and one: a value of one implying instantaneous adjustment, and a value of less than one implying a partial adjustment. Farmers' net investment behaviour may not necessarily be constrained in this way however; for instance, expectations of a future reduction in the price of capital may postpone net investment, implying a negative b, ceteris paribus.

6.2.1 Determinants of desired capital stock

If farmers were motivated towards maximising profits, their optimal levels of capital stock would be those where the marginal revenue product of capital was equal to the cost of capital services. A change in the price ratio of capital services to product price would lead to a change in demand for capital goods. In a perfectly competitive world, the cost of new capital services would be measured by the opportunity cost of capital. In an imperfect world, the opportunity cost would need to account for the influence of uncertainty, taxation and capital price appreciation.[2]

The service prices calculated by Morgan and Evans (1982) and described in Section 3.6, were from a larger set of North Island Hill and Hard Hill country farmers surveyed by the MWBES. It was assumed that these service prices approximated the cost of capital services faced by the farmers in this study.[3] The MWBES prices received index was used as a measure of the price of output. This index assumed product prices were fixed from the farmers' point of view and the weighting procedures for the various products (meat and wool) was the same for all farmers in the study.

Because the future was not known with certainty, farmers were assumed to form expectations of the cost of capital to product price ratio from past experience. It was assumed that expectations were the same for all farmers in addition to all farmers facing the same capital and output prices. Two formulations of expectations were hypothesised, one used the price ratio in the previous year, the other, the average of the price ratios of the two previous years. These formulations can be expressed algebraically as;

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2 This is discussed in Section 2.4.

3 Section 4.5.5 shows how these service prices were aggregated.

$$PC_t^* = PC_{t-1} \qquad (6.2)$$

$$PC_t^* = \sum_{i=1}^{2} PC_{t-i}/2$$

where: PC_t^* = expected price ratio in year t
PC_{t-i} = actual price ratio in year t-i

The New Zealand Government attempted to influence the environment in which farmers operated throughout the 1970s.[4] In particular, from 1975/76 to 1980/81, various policy schemes were introduced with the objective of increasing farm output. It was hypothesised that these policies combined to produce an environment that encouraged an increased level of capital stock on farms. It was not likely that the combined effect of these policies affected farmers desired capital stock by a constant amount per farm, since farms vary in size and capital intensity. Rather, it was assumed that the level of desired capital stock was raised by a constant amount per hectare through the introduction of these policies. This was achieved by multiplying the policy variable by farm size.

The ad hoc nature of the various policy measures introduced by Government over the 1970s, meant that continuation or alteration of schemes were announced in the Budget, normally in June each year. Schemes such as product price stabilisation were subject to yearly review, stabilisation levels being set late in the calendar year when farmers were already committed to their annual production plans. It was hypothesised that the policy environment in the preceding year determined farmers' expectations of policy conditions in the current year, due to the absence of noticeable long-term trends in the type and level of Government support to farming.

The period of study covers eight years, during which time technological change may have occurred. The

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4 A description of these policy measures is included in Section 1.1

recognition, for instance, of the influences that the state of pasture development and controlled grazing were observed to have on levels of output may have had a positive influence on desired capital stock. Various technological changes which may not have been included in relative prices were also evident over the 1970s. These included for instance covered yards and all-weather cabs on tractors. These non-price influences could be expected to have a positive effect on the desired stock of capital. Technological change was therefore hypothesised to have a positive influence on desired capital stock. Such change was measured with the use of a time trend variable in the absence of any other knowledge about the actual technology-change process.

The individual farms in the study differed in aspects such as size, location, initial states of development, farm class and owner's age. Therefore, even if all farmers faced the same level of expected real capital price, identical technology, and the same policy environment, individual farms could differ in their desired demand for capital. In particular, because the data are expressed in units per farm, it was expected that, ceteris paribus, larger farms would desire more capital than small farms. Objectives other than profit maximisation could also lead to differences in capital demands on individual farms. These cross-section effects were initially expected to be captured by specification of individual farm dummy variables. Inclusion of candidate variables likely to explain these cross-sectional differences would be attempted in later empirical analyses (section 6.5).

6.2.2 An initial specification of the demand for capital stock

An initial specification of the demand for desired capital stock supposes demand to be a linear function of the expected price ratio of capital services to product price, of Government policy, technological change and individual cross-section effects. This relationship can be expressed algebraically as:

$$K_{it}^* = a_1 + a_2\, PC_{.t}^* + a_3\, HAP_{it-1} + \sum_{j=2}^{21} \alpha_j\, DV_j + a_4 T_i + u_{it} \qquad (6.3)$$

where: K_{it}^* = desired capital stock on farm i in year t

$PC_{.t}^*$ = expected ratio of capital service price to product price in year t

HAP_{it-1} = $(HA_{it} \times P_{t-1})$ = expected Government policy in year t

HA_{it} = effective farm area on farm i in year t

P_{t-1} = policy dummy variable
= 0, for 1973/74 and 1974/75
= 1, for all later years

DV_j = dummy variable, = 1 for farm j, zero otherwise

T_i = time trend for farm i,
= 1 in 1974/75 up to 7 in 1980/81

a_1 = intercept for farm 1

a_2, a_3, a_4 = constants to be determined

$a_1 + \alpha_j$ = intercepts for farms j, j=2,.... 21

6.2.3 The rate of adjustment and liquidity

Campbell (1959) reported that Australian farmers, unlike corporate firms, accumulated farm capital by the physical efforts of themselves and their families, and investment finance came primarily from the plough-back of farm generated funds. Waugh (1977) developed this observation and proposed the hypothesis that the rate of adjustment of actual capital stock to be the desired level was influenced by the level of farm liquidity. Thus, an increase in the availability of funds was expected to increase the amount of investment each year.

Should a farmer hold a preference to finance investment from internally generated funds, then the amount of cash he has on hand at the beginning of each year would be an important variable in his budget planning for the year ahead. A farmer with a large opening real cash balance, ceteris paribus, was hypothesised to spend more on investment than a farmer with a small opening real cash balance. The calculation of real opening cash balance was described in Section 4.5.3.

Real net cash farm incomes can be expected to vary from one year to the next. This can be due to production variability caused by weather and management mistakes, and market uncertainties due to the inability of farmers to influence product and input prices which are themselves subject to variation. It was hypothesised that farmers have some notion of expected income variation that is, 'normal' upper and lower income limits, and any variation in real net income outside of these limits would be a windfall gain or loss. It was proposed that that part of real net cash income outside the bounds of 'normal' variation would contribute towards an increased (if positive) or reduced (if negative) rate of investment in that year. Such expenditure could also be incurred in an attempt to reduce income tax liability in the subsequent year. Campbell (1952) defined this unexpected variation in net income as transitory income, to distinguish it from the permanent, or expected, income variation. The calculation of transitory income for this study was described in Section 4.5.4.

A change in monetary conditions in the economy was expected to influence the availability of investible funds from external sources to the farmer. Difficulty in specifying external liquidity conditions facing New Zealand farmers was experienced in this study. This was because the chief source of external funds to farmers was the Rural Bank, whose funds availability was already reflected in the policy variable in equation (6.3). Waugh (1977) attempted to measure change in external liquidity by the change in a farmer's debt. In the present study, it was thought dangerous, however, to ascribe past changes in debt solely to changes in monetary conditions or that past changes in farm debt had anything to do with the current availability of external funds. Moreover, changes in the farmer's level of investment may well have changed his debt situation, rather than vice versa. Therefore, no allowance was made for external liquidity in the initial equation. However, inclusion of either of two aggregate variables, growth in money supply and advances to farmers, were included in later regression equations.

6.2.4 An initial specification of the rate of adjustment of actual capital stock to the desired level

Following Waugh (1977), it was hypothesised that the rate of adjustment of capital stock to the desired level was a linear function of the real cash balance of the farm at the beginning of the year, and real transitory income, both measured relative to desired investment. This suggested that for a given level of liquidity, the rate of adjustment was quicker the closer actual capital stock was to its desired level. This function can be expressed algebraically as:

$$b_{it} = b_o + b_1 \frac{CB_{it-1}}{K_{it}^{*}-K_{it-1}} + b_2 \frac{TR_{it}}{K_{it}^{*}-K_{it-1}} + e_{it} \qquad (6.4)$$

where: b_{it} = the overall adjustment coefficient

CB_{it-1} = the opening real cash balance of farm i in year t

TR_{it} = real transitory income[5]

b_o, b_1, b_2 = constants to be determined

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5 In calculating transitory income an estimate of 'normal' income variation was needed. 'Normal' income variation for each farm was taken to be the mean absolute change in real cash income over the data period. It was assumed for each farm that the mean absolute change in real cash income over the data period was the same as that before the data period when these expectations would actually have been formed.

6.2.5 An initial reduced form estimating equation

Equations (6.1), (6.3) and (6.4) comprise a simultaneous set. The reduced form equation is obtained by substituting (6.3) and (6.4) into equation (6.1), and gathering terms. This yielded the following equation for use in empirical analyses:

$$I_{it} = a_1b_0 + \sum_j b_0\alpha_jDV_j + a_2b_0PC_t^* + a_3b_0HAP_{it-1}$$

$$+ a_4b_0T_i + b_1CB_{it-1} + b_2TR_{it}-b_0K_{it-1} + v_{it} \qquad (6.5)$$

The error term (v_{it}) in equation (6.5) is complex, being a conglomerate of error terms, coefficients and variables. In all empirical analyses it was assumed that the error term was normally distributed with a zero mean and a constant variance. Ordinary least squares could then be used to estimate the equation. In practice, however, nothing was known about the true characteristics of this error term and the results need to be interpreted with this caution in mind. Note that b_0 is directly estimated in (6.5), so that the values of α_j, a_1, a_2, a_3 and a_4 can be subsequently derived.

6.3 The initial regression results

6.3.1 Introduction

This section presents the search for an empirical quantification of the model that best explains investment decision making on the individual farms in this study. The regression equations were explained for their explanatory power and the size and sign of their regression coefficients. Having chosen a model which best explained investment behaviour, attention was then given to reducing the explanatory power of the individual farm dummy variables as a group, by replacing them with candidate variables considered important in explaining cross-section differences.

6.3.2 The regression results

The estimated regression coefficients of equation (6.5) are presented in Table 6.1 . The first regression (equation 1), without the farm dummy variables included had a low explanatory power, with an adjusted R-square of 16 percent. Except for the price of capital, lagged capital stock and time trend, each coefficient had the anticipated sign. Only the policy variable was significant, at the one percent level.

Inclusion of the farm dummy variables (equation 1a), improved the explanatory power of the equation to an adjusted R-square of 37 percent. An F-test on the inclusion of the farm dummy variables indicated that these variables significantly improved the explanatory power of the equation at the one percent level.[6] The time trend coefficient had the expected sign but was not significantly different from zero. The capital price coefficient remained of the wrong sign, and was not significant.[7] The other coefficients were of the expected sign and were significant at the 13 percent level or better. The transitory income coefficient remained approximately constant with inclusion of the farm dummy variables, indicating that this variable was not influenced by other, unmeasured, cross-section differences.

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6 The null hypothesis, $H_0 : I = (X)$ where X = the set of explanatory variables, was set against the alternative $H_A : I = (X,DV)$, where X = the same set of explanatory variables and DV = the set of farm dummy variables, with

$$F=\left[\frac{RSS(H_A)-RSS(H_0)}{20}\right] / EMS(H_A).$$

7 A separate regression assumed the expected real price of capital to be the average of the capital to product price ratios of the previous two years (as described in Section 6.2.1). These regression results are not reported as the coefficient for the real price of capital had the correct sign but a t-ratio of -0.15, with farm dummy variables included.

As would be expected, removal of the real price of capital and trend variables in equations 2 and 2a did not appreciably change the explanatory power of the equation. As with the first pair of equations, inclusion of the farm dummy variables considerably improved some of the t-ratios and the R-square value.

Table 6.1: Initial Regression Results

Farm Dummies Equation Number	No 1	Yes 1a	No 2	Yes 2a
Constant	121.076 (0.05)	6554.558 (1.93)	1705.853 (2.14)	7035.512 (2.82)
$PC^*_t = PC_{t-1}$	15188.262 (1.39)	650.824 (0.07)		
HAP_{it-1}	6.726 (3.93)	3.659 (2.08)	4.447 (3.68)	4.432 (3.63)
T_i	-248.009 (1.05)	160.975 (0.72)		
CB_{it-1}	0.004 (0.15)	0.077 (1.51)	-0.003 (0.10)	0.068 (1.39)
TR_{it}	0.123 (1.44)	0.155 (1.90)	0.117 (1.36)	0.147 (1.83)
K_{it-1}	0.0005 (0.12)	-0.049 (3.06)	0.003 (0.84)	-0.046 (3.09)
R^2	.197	.482	0.174	0.480
$\bar{R}^2$	.163	.370	0.151	0.378
SE	4037.41	3501.41	4064.77	3480.15
F test of farm DV	3.31		3.59	

Note: t-values in parentheses
critical values:

$t_{.01} = 2.62$

$t_{.05} = 1.98$

$t_{.10} = 1.66$

$t_{.15} = 1.47$

critical values of F-statistic for d.f. $\sim$ (20,150)

$>F_{.05} = 1.64$

$>F_{.01} = 2.00$

6.4 Regression results testing alternative formulations of transitory income

The initial formulation of the model supposed the same absolute relationship between net investment and transitory income, irrespective of whether transitory income was positive or negative. To test this supposition, two new variables were computed, splitting transitory income into its positive (real net income change greater than 'normal') and negative (real net income change less than 'normal') components. The regression results obtained when the initial transitory income formulation was replaced with these two variables are presented in Table 6.2.

Specification of positive and negative transitory income variables marginally reduced the explanatory power of the model over equation 2a as measured by the adjusted R-square. Comparing the size of the three transitory income coefficients, the TR_{it} coefficient was midway in size between those for the TRN_{it} and TRP_{it} variables. The coefficients of neither TRN_{it} nor TRP_{it} were significant at the five percent level. TRP_{it} was significant at the ten per cent level. This suggested that positive transitory income contributed towards increased net investment, but that farmers would not disinvest when transitory income was negative. When this suggestion was tested, that is by setting a null hypothesis that the difference between the coefficients of TRN_{it} and TRP_{it} equalled zero, with the alternative hypothesis that there was a difference between the two coefficients, the t-ratio was calculated as 0.64. The null hypothesis could not therefore be rejected. It was thus assumed the coefficients of TRN_{it} and TRP_{it} were the same. Equation 3a was thus rejected as an improvement to the investment decision model quantified in equation 2a.

Table 6.2: Regression Results Testing Alternative Formulations of Transitory Income

Farm Dummies	No.	Yes
Equation Number	3	3a
Constant	1602.866 (2.01)	6899.776 (2.57)
HAP_{it-1}	4.482 (3.73)	4.429 (3.62)
CB_{it-1}	0.002 (0.07)	0.072 (1.47)
TRN_{it}	-0.026 (0.21)	0.094 (0.81)
TRP_{it}	0.259 (2.06)	0.202 (1.71)
K_{it-1}	0.002 (0.55)	-0.046 (3.08)
R^2	0.188	0.482
$\bar{R}^2$	0.159	0.375
SE	4054.14	3488.66
F-test of farm D.V.	3.42	

Note: TRN_{it} = negative transitory income

TRP_{it} = positive transitory income

t values in parentheses

critical values

$t_{.01} = 2.62$

$t_{.05} = 1.98$

$t_{.10} = 1.66$

$t_{.15} = 1.47$

critical values of F-statistic for d.f. $\sim (20,150)$

$> F_{.05} = 1.64$

$> F_{.01} = 2.00$

6.5 Explanation of inter-farm differences in the constant term

6.5.1 Candidate variables explaining cross-sectional differences

Use of the individual farm dummy variables have been shown to have significantly increased the explanatory power of regression equations 1, 2, and 3. The farm descriptions of Chapter 5 provided a base for the search for candidate variables explaining these cross-sectional differences in farm net investment decision making. Candidate variables included farm size, location and type, initial state of development, level of output and farmer age. These variables were initially tabulated against the size of the farm dummy coefficients of equation 2a to see if a relationship existed.

A positive relationship between farm size and demand for capital was expected. This would be in accordance with profit maximising rules whereby larger farms would demand more capital, ceteris paribus, per farm. The tabulation of farm dummy coefficients per farm with effective farm area indicated a strong positive relationship between the two. Effective farm area in the current year was therefore postulated to explain some cross-sectional differences.

A negative relationship between farmer age and demand for capital was expected. The tabulation of farm dummy coefficients per farm with approximate farmer age suggested this relationship. Reasons for younger farmers demanding more capital than older farmers could include: having a longer planning horizon, a willingness to accept risky outcomes, more physical energy, a desire to do something different from the previous owner (often the father) of the farm or less importance placed on drawings, personal capital or off-farm investment.

Classification of the survey farms in Chapter Five into groups of similar initial states of development indicated more similarities in net investment behaviour within groups. In particular, the undeveloped farms were observed to be generally spending more on net investment than their well-developed counterparts. It does not follow, however, that the former farms would desire a higher level of capital than the latter, since this investment behaviour could be explained by the size of b_t, or the difference between K_t^* and K_{t-1}. This can be illustrated with three examples, the purposes of which are to show that there need be no a priori reason for either a positive or negative relationship between "initial development state" and net investment, or between "initial development state" and desired capital stock.

The model developed in Section (6.1) to (6.3) is illustrated in Figure 6.1. Here it is assumed K_t^* is the same for two farms, although at time t-1, farm 2 is at a lower level of development than farm 1. In this model, the effect of initial development state is incorporated in K_{it-1}.

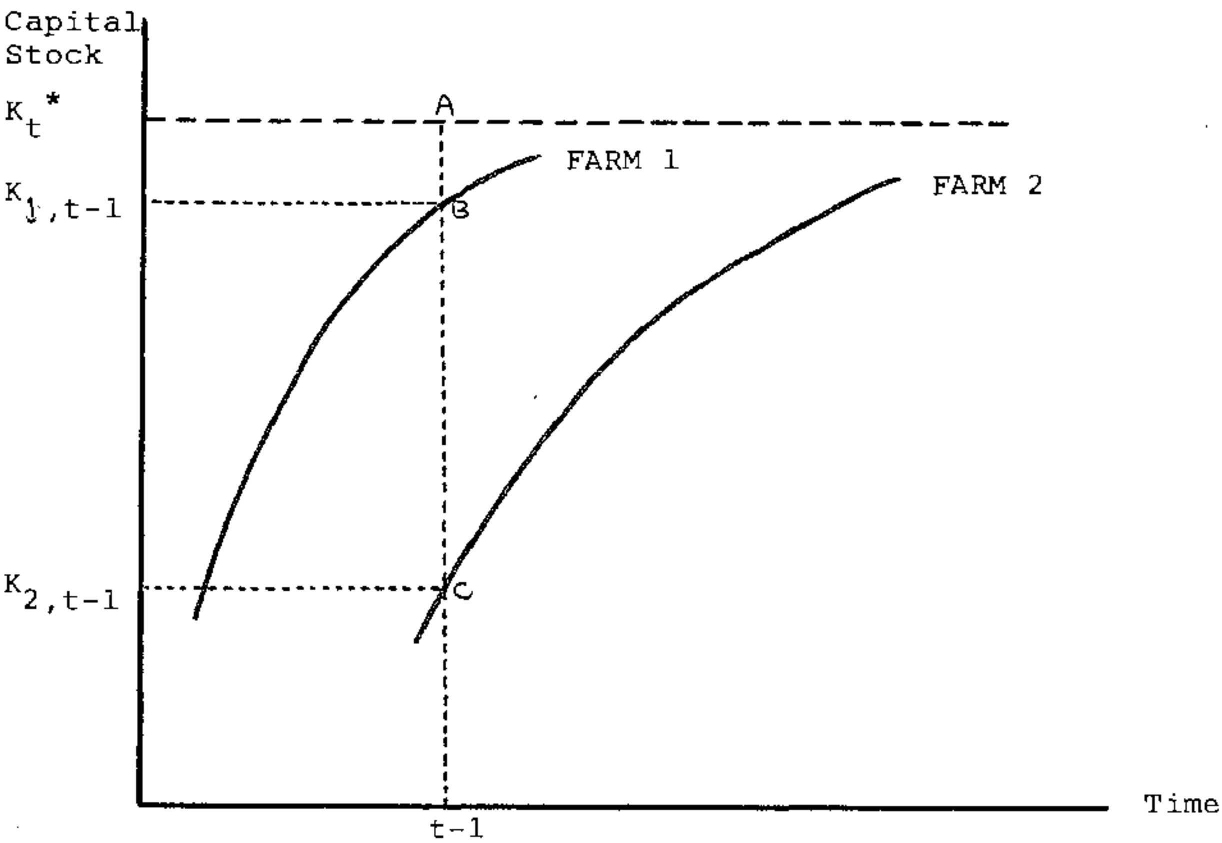

Figure 6.1: Growth Path of Capital Stock - Example 1

Thus if K_t* and b_{it} were the same for farms 1 and 2, then:

$I_{1,t} \quad = b_{1t}(K_t^* - K_{1,t-1}) = \beta(AB)$
$I_{2,t} \quad = b_{2t}(K_t^* - K_{2,t-1}) = \beta\ (AC)$
$\beta(AB) < \beta\ (AC)$

where: I_{it} = net investment on farm i in year t

Desired and actual investment are greater on farm 2 because of the lower initial state of development on farm 2. However, farm 1 could spend more on net investment than farm 2 if b1 > b2, because farm 1 may have larger cash balances than farm 2.

A second situation is illustrated in figure 6.2. In figure 6.2 it is assumed that farm 2, the 'undeveloped' farm at time t-1, does not desire the same level of capital stock to achieve a state of 'full development' as farm 1, a 'well-developed' farm at time t-1. An undeveloped farm at time t-1, may use inputs such as electric fencing and oversowing to achieve desired capital stock. A well-developed farm in contrast may be locked into an older capital system where the nature of 'full development' desires a high level of capital, such as eight-wire fences and cultivation.

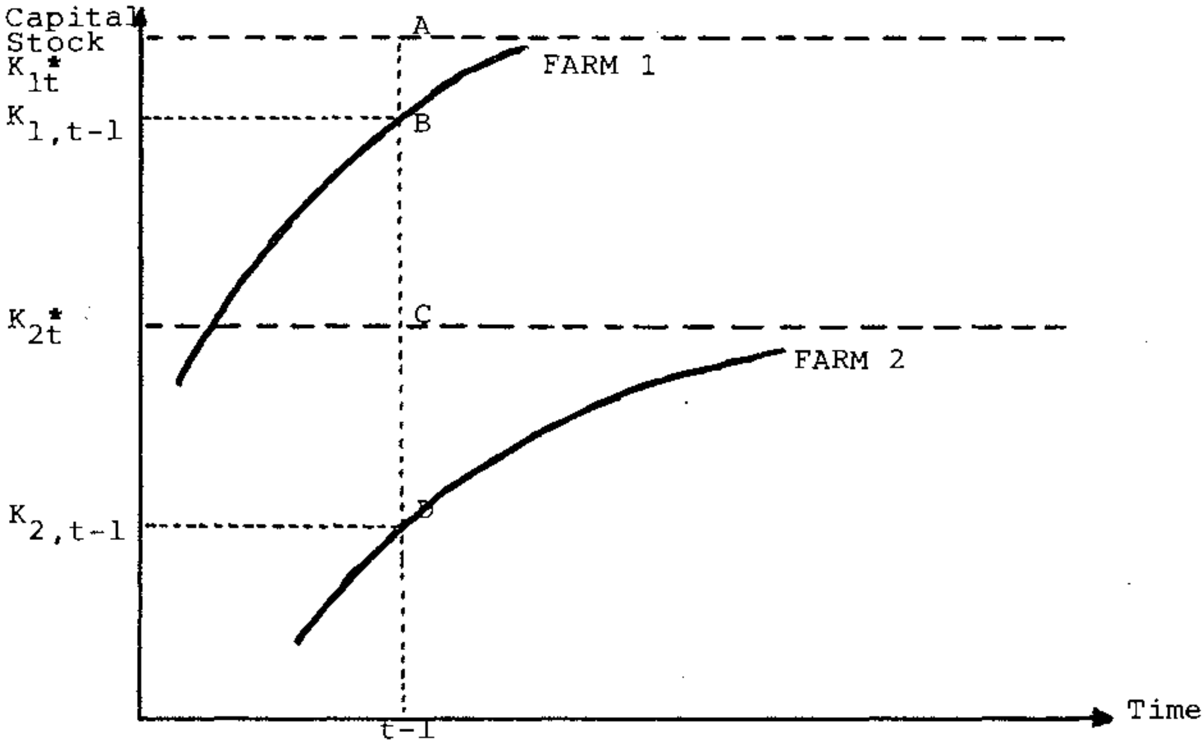

Figure 6.2: Growth Path of Capital Stock - example 2

From Figure 6.2,

$$I_{1,t} = b_1(K_{1,t}^* - K_{1,t-1}) = b_1(AB)$$

$$I_{2,t} = b_2(K_2^*{}_{,t} - K_{2,t-1}) = b_2(CD)$$

where: I_{it} = net investment on farm i in year t.

Again, whether farm 1 spends more or less than farm 2 on net investment will depend on the relative size of b_1 and b_2.

However if 'well-developed' farms are locked into a higher desired capital stock, a positive relationship between 'initial development state' and desired capital stock would be expected.

In contrast to the example above, an 'undeveloped' farm may desire more capital stock than a 'well-developed' farm to achieve a state of 'full development', due to the availability of more capital-intensive technologies that farm 1, for various reasons, does not choose to adopt. If 'undeveloped' farms desire higher levels of capital stock than 'well-developed' farms, a negative relationship between 'initial development state' and desired capital stock would be expected.

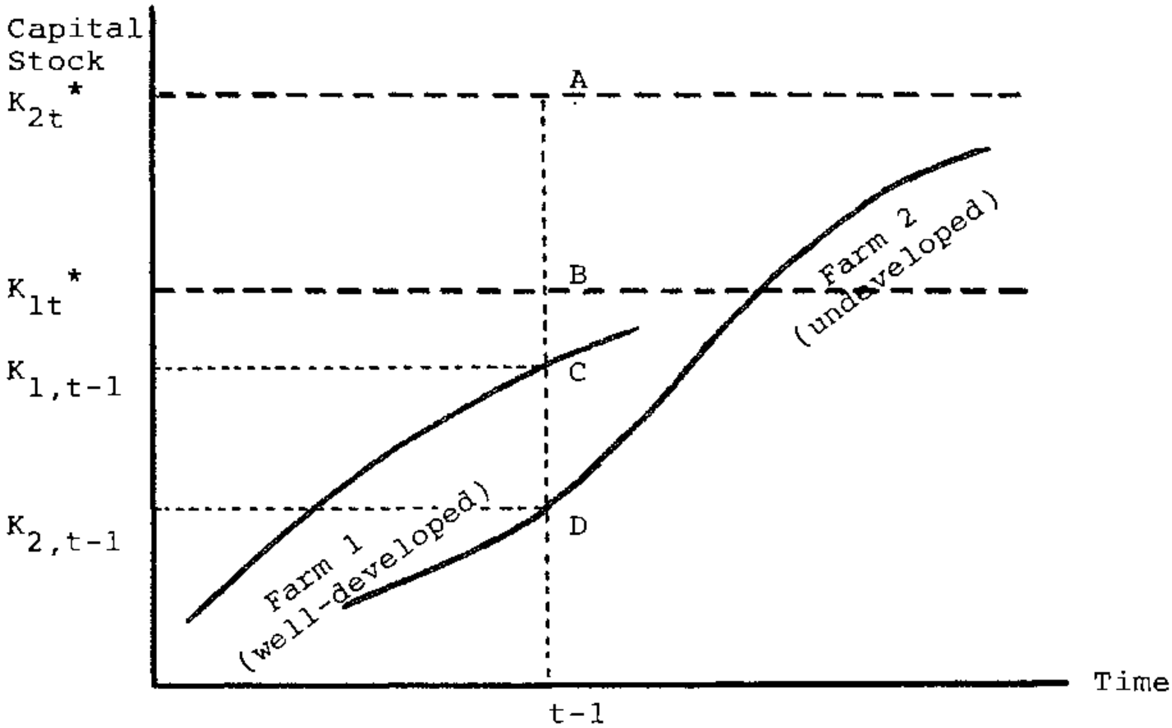

Table 6.3: Growth Path of Capital Stock - Example 3

For this study, the possibility that there may be a positive or negative relationship between 'initial development state' and desired capital stock is recognised. If regression results indicate a 'significant' relationship, this could become an aspect for further research.

6.5.2 Regression results explaining cross-section differences

6.5.2.1 Farm size, farmer age, initial development state

The regression results of successive additions of the farm size, farmer age and initial development state variables to equation 2 are presented in Table 6.3. The aim of successive additions of these variables was to reduce the significance of the farm dummy variables to a level where their inclusion in the equation did not significantly add to its explanatory power.

The inclusion of the farm size variable (HA_{it}) in equation 4, without the farm dummy variables, doubled the explanatory power of equation 2, in terms of adjusted R-square. The farm size coefficient had the anticipated sign and was significant at the one percent level. Comparing equations 2 and 4, the size of each coefficient except for the policy coefficient, increased. Each coefficient was significant at the one percent level, except for transitory income, which was significant at the five percent level. Inclusion of the farm dummy variables to equation 4 (equation 4a) did not substantially change the size of the coefficients. However, the significance of the transitory income and opening cash balance coefficients fell, the former to be significant at the five percent level, the latter significant at the 17 percent level. The adjusted R-square of equation 4a was marginally greater than equation 2a. An F-test on the inclusion of the farm dummy variables to equation 4, showed their inclusion added to the explanatory power of the equation at the five percent level.

Table 6.3: Regression Results Testing Significance of Candidate Variables Explaining Cross-sectional Differences

Farm Dummies	No.	Yes.	No.	Yes.	No.	Yes.	No.	Yes.
Equation Number	4	4a	5	5a	6	6a	7	7a
Constant	1189.83 (1.62)	3012.88 (1.33)	5314.35 (3.08)	8144.54 (1.40)	-1418.99 (0.81)	-1695.82 (0.55)	2341.92 (1.18)	556.36 (0.14)
HAP_{it}	3.031 (2.68)	4.253 (3.50)	2.888 (2.60)	4.090 (3.33)	3.394 (2.96)	4.227 (3.5)	3.469 (3.15)	4.052 (3.31)
CB_{it-1}	0.098 (3.10)	0.065 (1.36)	0.099 (3.20)	0.072 (1.48)	0.087 (2.69)	0.065 (1.35)	0.080 (2.58)	0.071 (1.47)
TR_{it}	0.175 (2.22)	0.138 (1.72)	0.155 (2.00)	0.127 (1.57)	0.166 (2.11)	0.137 (1.71)	0.132 (1.73)	0.125 (1.54)
K_{it-1}	-0.025 (4.01)	-0.048 (3.15)	-0.024 (3.85)	-0.047 (3.08)	-0.032 (4.27)	-0.048 (3.15)	-0.036 (4.88)	-0.047 (3.08)
HA_{it}	13.211 (5.47)	17.462 (4.46)	11.739 (4.83)	15.530 (3.64)	15.855 (5.50)	19.295 (4.52)	15.802 (5.70)	18.496 (4.25)
AGE_i			-79.562 (2.63)	-69.996 (0.96)			-110.394 (3.51)	-70.521 (0.96)
$DEV_{i,74}$					5.765 (1.65)	6.516 (1.04)	10.100 (2.83)	10.586 (1.40)
R^2	0.319	0.482	0.352	0.486	0.333	0.482	0.387	0.486
$\bar{R}^2$	0.295	0.380	0.324	0.380	0.304	0.380	0.356	0.380
SE	3703.89	3474.49	3625.43	3475.56	3681.17	3473.84	3540.75	3475.83
F-test of farm DV	1.91		1.58		1.76		1.16	

T-statistics in brackets critical values

$t_{.01} = 2.62$ $t_{.05} = 1.98$
$t_{.10} = 1.66$ $t_{.15} = 1.97$

Critical values of F-statistic:

for d.f. ∿ (20,150)
$> F_{.05} = 1.64$

The addition of the age variable (AGE_i) to equation 4 (equation 5) raised the adjusted R-square by three percent to 32.4 percent.[8] The age coefficient had the anticipated sign and was significant at the one percent level. Inclusion of the farmer age variable did not substantially alter the size or significance of the other coefficients. Addition of the farm dummy variables to equation 5 (equation 5a) raised the explanatory power of the equation to that of equation 4a. The significance of the farmer age coefficient, however, fell to greater than 15 percent. An F-test showed the addition of farm dummy variables did not add to the explanatory power of equation 5 at the five percent level, although at 1.58 the F-value was not far below the critical value.

Equation 6 excluded the farmer age variable but included the farm capital value per hectare in 1973/74 as a measure of initial state of development variable. The explanatory power of the equation, as measured by the adjusted R-square was marginally greater than equation 4. The initial state of development coefficient had a positive sign, and was significant at the ten percent level. All other coefficients did not substantially alter in size and were significant at the one percent level. Inclusion of farm dummy variables (equation 6a) did not substantially alter the size of each coefficient, but reduced the significance of each coefficient. The adjusted R-square was again raised to that of equation 4a. An F-test on the inclusion of the farm dummy variables showed their inclusion significantly added to the explanatory power of the equation at the five percent level.

Equation 7 includes all three candidate variables hypothesised as explaining cross-sectional differences in investment behaviour. The transitory income coefficient was significant at the ten percent level, all other variables were significant at the one percent level. The adjusted R-square of equation 7 was raised to 35.6 percent. Inclusion of the farm dummy variables (equation 7a) raised

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8 Except for farms 6, 9, 11 and 15 farmer age is the approximate age of the farmer in 1973/74. Farms 6, 9, 11 and 15 changed ownership over the data period and AGE_i changes to the approximate ages of the new owners when the farm is sold.

the adjusted R-square an additional 3.5 percent. However, the F-test on their inclusion indicated the farm dummy variables did not significantly add to equation 7's explanatory power at the five percent level.

6.5.2.2 Region and Farm Type

Inspection of the significance levels of the individual farm dummy coefficients in equation 7a, indicated that only the dummy coefficients for farms 5, 6, 7 and 8 entered the equation at significance levels of less than twenty-five percent. These four farms comprised one-half of the West Coast, North Island farms in the survey. It was hypothesised therefore that West Coast farms desire more capital stock than their Wairarapa counterparts. This could be due to better climate, better regional infrastructure, larger local markets or other reasons. A further hypothesis to be tested is that the demand for capital stock varies significantly between farm types.

Table 6.4 presents the regression results testing the above hypotheses. In equation 8, a region dummy variable ($R1_i$=1 if farm i is a West Coast farm, otherwise equals zero) and a farm type dummy variable ($T1_i$=1 if farm i is a Hill Country farm, otherwise equals zero) were specified in an attempt to further explain cross-section differences. The region coefficient had the expected sign but was not significant at the ten percent level. The farm type coefficient was not significant at the ten percent level. Inclusion of these two variables did not substantially alter the size or significance of the other coefficients when comparing equations 7 and 8. Inclusion of the individual farm dummy variables in equation 8a did not add to the explanatory power of the equation at the five percent level. The overall explanatory power of equations 8 and 8a, in terms of adjusted R-square were less than equations 7 and 7a.

Table 6.4: Regression Results Testing Significance of Regional and Farm Type Variables

Farm Dummies	No	Yes	No	Yes
Equation Number	8	8a	9	9a
Constant	1892.665 (0.93	-3169.436 (0.94)	2647.648 (1.28)	355.227 (0.11)
HAP_{it}	3.561 (3.22)	4.020 (3.30)	3.532 (3.21)	4.052 (3.32)
CB_{it-1}	0.072 (2.24)	0.070 (1.46)	0.068 (2.15)	0.071 (1.47)
TR_{it}	0.131 (1.72)	0.123 (1.53)	0.133 (1.76)	0.125 (1.55)
K_{it-1}	-0.036 (4.83)	-0.047 (-3.08)	-0.034 (-4.56)	-0.047 (-3.08)
HA_{it}	15,783 (5.68)	20,782 (3.88)	14,850 (5.25)	18,442 (4.17)
AGE_i	-94.943 (-2.67)	-71.072 (-0.97)	-91.075 (-2.57)	-70.554 (-0.97)
$DEV_{i,74}$	8.926 (2.10)	11.253 (0.82)	7.677 (1.79)	11.566 (1.33)
$R1_i$	822.112 (1.13)	616.087 (0.21)		
$T1_i$	-13.929 (-0.02)	2139.746 (0.87)		
$R1T1_i$			-989.334 (0.97)	-424.889 (-0.12)
$R1T2_i$			-467.899 (-0.42)	-2452.529 (-0.93)
$R2T1_i$			-669.735 (-0.75)	-813.062 (-0.31)
R^2	0.393	0.486	0.403	0.486
$\bar{R}^2$	0.353	0.379	0.359	0.379
SE	3599.899	3476.38	3532.396	3475.818
F-test of farm D.V.	1.09		0.97	

Note: t-values in parentheses
critical values

$t_{.01} = 2.62$
$t_{.05} = 1.98$
$t_{.10} = 1.66$
$t_{.15} = 1.47$

critical values of F-statistics for d.f. ∿ (20,150)

$> F_{.05} = 1.64$
$> F_{.01} = 2.00$

In equation 9, the possibility of interactions between regions and farm types was examined. To allow the region effect to differ between both farm types and vice versa, a new set of dummy variables were created as:

$R1T1_i$ = 1 if farm i is a West Coast, Hill Country farm,
= 0 otherwise.
$R1T2_i$ = 1 if farm i is a West Coast, Hard Hill Country farm,
= 0 otherwise.
$R2T1_i$ = 1 if farm i is a Wairarapa Hill Country farm,
= 0 otherwise.

None of these coefficients entered the equation at significance levels of less than ten percent. The size and significance of the other coefficients were not substantially different to those in equation 7. Inclusion of the individual farm dummy variables to equation 9 did not add to the explanatory power of the equation at the five percent level. Region and farm type differences were thus rejected as variables explaining cross-sectional differences.

6.6 Regression results on removing non-significant farm dummy variables

From Section 6.5 it was accepted that farm size, farmer age and initial development state explained much of the inter-farm differences in the constant term. When these three variables were included in equation 7a, the farm dummy variables as a group were not significant at the five percent level by F-test. However, four dummy variables, for farms 5, 6, 7 and 8 entered the regression equation at significance levels of between five and twenty-five percent. The remaining dummy variables entered the equation at significance levels of 38 percent or greater.

Table 6.5 presents the regression results from including only the farm dummy variables for farms 5, 6, 7 and 8 in equation 7. Except for farm 8, the farm dummy variable coefficients were significant at the fifteen percent level. Except for farmer age, the coefficients of the remaining variables did not substantially alter in size or significance levels. The farmer age coefficient was reduced in size by approximately 50 percent and was not significant at the ten percent level.

Table 6.5: Regression Results Including the Farm Dummy Variables for Farms 5, 6, 7 and 8

Equation	7	7b
Constant	2341.92 (1.181)	-671.56 (0.310)
HAP_{it}	3.469 (3.151)	3.687 (3.514)
CB_{it-1}	0.080 (2.580)	0.066 (2.103)
TR_{it}	0.132 (1.738)	0.119 (1.647)
K_{it-1}	-0.036 (4,885)	-0.036 (4.861)
HA_{it}	15,802 (5.706)	16.537 (6.046)
AGE_i	-110.394 (3.511)	-49.097 (1.471)
$DEV_{i,74}$	10.100 (2.832)	9.169 (2.415)
DV for farm 5		4718.567 (3.177)
DV for farm 6		3403.112 (2.338)
DV for farm 7		2283.373 (1.605)
DV for farm 8		-1991.767 (1.420)
R^2	0.387	0.465
$\bar{R}^2$	0.356	0.422
SE	3540.75	3355.68
F-test of farm DV's	0.887	

Note: t-statistic in brackets;

critical values $t_{.01} = 2.62$

$t_{.05} = 1.98$

$t_{.10} = 1.66$

$t_{.15} = 1.47$

The explanatory power of equation 7b, as measured by the adjusted R-square, was 42.2 percent, the highest of the regression equations tested.

From the coefficients of equation 7b the parameters of the original three-equation model can be derived as follows:

$a_1 b_o$	= -671.56	a_1	= -18654.44
$a_2 b_o$	= 3.687	a_2	= 102.42
$a_3 b_0$	= 16.537	a_3	= 459.36
$a_4 b_0$	= -49.097	a_4	= -1363.81
$a_5 b_0$	= 9.169	a_5	= 254.69
b_1	= 0.066		
b_2	= 0.119		
b_o	= 0.036		
For farms 5 to 8			
$DV_5 b_0$	= 4718.567	DV_5	= 131071.30
$DV_6 b_0$	= 3403.112	DV_6	= 94530.89
$DV_7 b_0$	= 2283.373	DV_7	= 63427.03
$DV_8 b_0$	= -1991.767	DV_8	= -55326.86

These parameters can be substituted into the three-equation model as follows:

$$K_{it}^{*} = \text{CONST} + 102.4\ HAP_{it} + 459.4\ HA_{it} - 1{,}363.8\ AGE_i + 254.7 DEV_{i,74}$$

$$b_{it} = 0.036 + 0.666 \frac{CB_{it-1}}{K_{it}^{*} - K_{it-1}} + 0.119 \frac{TR_{it}}{K_{it}^{*} - K_{it-1}}$$

$$I_{it} = b_{it} (K_{it}^{*} - K_{it-1})$$

where: CONST = -18,564 for farms 1-4, 9-21

= (-18,564 + 131,071) for farm 5

= (-18,564 + 94,531) for farm 6

= (-18,564 + 63,427) for farm 7

= (-18,564 - 55,327) for farm 8

6.7 Interpretation of the coefficients of the chosen equation

6.7.1 The chosen equation

Equation 7b was chosen as the regression equation best explaining net investment decision making on the survey farms. The adjusted R-square was the highest of the equations tested, the size of the coefficients appeared reasonable, the coefficients were stable, their sign met expectations, and they were significant at a reasonable level. Also, except for farms 5, 6, 7 and 8 individual cross-section behaviour had been satisfactorily explained (at least when attention was confined to the intercept of the equations) by effective farm area, farmer age and initial development state. It was felt that, within the confines of this study, the gathered data could not contribute more to explaining why farms 5, 6, 7 and 8 differed in their net investment decision making from the other survey farms.

6.7.2 The policy variable

With reference to Section 6.6, equation 7b indicated that the combined influence of the policy schemes introduced in the mid and late 1970s shifted the desired levels of capital stocks on the survey farms upwards by $102 per effective hectare, ceteris paribus. Inasmuch as this desired net investment could be financed, and led to increased output, it could therefore be argued the objective of these policy schemes were achieved.

6.7.3 The effective farm area variable

In the derivation of desired capital stock from equation 7b, an increase in effective farm area by one hectare led to an increase in desired capital stock by $459 per farm, ceteris paribus. This behaviour was consistent with profit maximising behaviour.

6.7.4 The farmer age variable

The derivation of desired capital stock from equation 7b indicated, ceteris paribus, an increase in farmer age of one year was associated with a reduction in capital stock by $1,363 per farm. Reasons for this behaviour could only be surmised.

Possible reasons include younger farmers having a longer planning horizon than older farmers, younger farmers being more willing to accept risky outcomes, and the influence of multiple objectives such as leisure/satisficing behaviour.

6.7.5 The initial state of development variable

In Section 6.5.1 three possible explanations of the growth of capital stock were hypothesised. Without a priori knowledge of the influence 'initial development state' had on desired capital stock, it was decided to test for a 'significant' relationship. The regression results indicated a positive relationship between 'initial development state' and desired capital stock which was significant at the one percent level. In the derivation of desired capital stock from equation 7b an increase in 'initial development state' of one dollar per hectare raised desired capital stock by $254 per farm. An explanation of this behaviour is that well-developed farms are locked into an older capital system where the state of 'full development' needs a higher level of capital stock. Because of improved inputs, undeveloped farms may not need the same level of desired capital stock to achieve a state of full development.

6.7.6 The opening cash balance variable

The availability of cash to the farmer at the beginning of each production year was assumed to encourage net investment. The regression results of equation 7b indicated that, ceteris paribus, an increase in one dollar of opening cash balance increased the rate at which capital stock adjusted to the extent that an extra six cents was invested. This was considerably less than the propensity to (net) invest of 0.2 obtained by Johnson (1971). However, Johnson's finding provided the linkage between net investment and farmers' previous net income streams. Six percent of the opening cash balance may well be twenty percent of the previous year's net cash income.[9]

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9 A check of the data found that on average, real net cash income was 2.8 times real opening cash balance.

6.7.7 The transitory income variable

It was hypothesised that that part of real net cash income outside the bounds of 'normal' variation (transitory income) would contribute towards an increased (if positive) or reduced (if negative) rate of investment in that year. The regression results of equation 7b indicated, ceteris paribus, that twelve cents of an additional dollar of transitory income was directed towards net investment, since the rate of adjustment was accelerated (slowed) by such income windfall (or losses).

6.7.8 The lagged capital stock variable

The negative value of the lagged real capital stock coefficient (K_{it-1}) cannot be interpreted as an inverse relationship to net investment. The coefficient of real lagged capital had a negative sign due to the derivation of the estimating equation. The lagged real farm capital coefficient in equation (6.4) was the term, b_0. The regression results of equation 7b indicated that even if there were no money available from opening cash balance or positive transitory income, net investment would advance autonomously at the rate of 3.6 percent of the desired level each year.

6.8 The overall rate of adjustment

The rate of adjustment of actual capital stock to the desired level on each survey farm for each year of the data period is presented in Table 6.6. These values were obtained from equation 7b as;

$$b_{it} = 0.036 + 0.066\left(\frac{CB_{it-1}}{K_{it}^{*} - K_{it-1}}\right) + 0.119\left(\frac{TR_{it}}{K_{it}^{*} - K_{it-1}}\right)$$

Inspection of Table 6.6 indicated the majority (over 70 percent) of the farm adjustment coefficients to be between the values of three and six percent. In other words, three to six percent of desired net investment was actually carried out each year on the majority of the survey farms over the data period.

Table 6.6: Overall Adjustment Coefficients (b Values) of the Invididual Survey Farms

	b Values							
Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81	Ave.
Farm								
1	0.138	0.083	0.134	0.070	0.066	0.093	0.046	0.090
2	0.037	0.026	0.026	0.037	0.030	0.034	0.029	0.031
3	0.049	0.049	0.045	0.044	0.047	0.045	0.043	0.046
4	0.489	0.128	0.830	0.091	0.038	0.052	0.131	0.251
5	0.038	0.037	0.047	0.045	0.040	0.042	0.041	0.041
6	0.052	0.042	0.037	0.040	0.039	0.041	0.038	0.041
7	0.039	0.034	0.032	0.035	0.038	0.039	0.045	0.037
8	0.030	-0.041	-0.015	0.139	0.125	0.110	-0.239	0.015
9	0.029	0.033	0.036	0.035	0.040	0.036	0.036	0.035
10	0.116	0.048	0.051	0.044	0.036	0.051	0.045	0.055
11	0.052	0.048	0.037	0.040	0.039	0.038	0.045	0.042
12	0.073	0.012	0.030	0.035	0.039	0.027	0.038	0.036
13	5.079	0.079	-0.083	0.069	0.056	0.085	0.082	0.766
14	0.043	0.044	0.050	0.042	0.038	0.043	0.037	0.042
15	0.041	0.017	0.053	0.038	0.036	0.038	0.032	0.034
16	0.031	0.030	0.032	0.035	0.036	0.039	0.038	0.034
17	0.029	0.034	0.033	0.033	0.028	0.028	0.029	0.030
18	0.028	0.029	0.032	0.025	0.038	0.042	0.039	0.033
19	0.014	0.028	-0.068	0.038	0.034	0.056	0.056	0.022
20	0.061	0.046	0.047	0.055	0.038	0.040	0.039	0.046
21	0.058	0.048	0.047	0.044	0.038	0.039	0.052	0.046
Ave.	0.310	0.040	0.068	0.049	0.043	0.048	0.032	0.085
Ave. Excl. Farm 13	0.072	0.038	0.075	0.048	0.043	0.046	0.030	0.050

The average adjustment coefficient for all survey farms over the data period was 8.5 percent. The abnormal value for farm 13 in 1974/75, however, gave this average considerable upwards bias. When farm 13 was excluded from the calculation, the average b value over the period was five percent. The average b value of the survey farms fell below five percent in 1975/76 and 1980/81. Opening cash balances on the survey farm in 1975/76 were generally low because of a large fall in product prices the previous year (as described in Section 1.1). Low opening cash balances and negative transitory income contributed to low b values in 1980/81.

Farm 4 had large positive b values. Farm 4 was characterised by small desired investment and large opening cash balances. This farm was a large, well-developed, highly productive farm, thus larger b values would be expected. Farms 8, 13 and 19 had negative b values in some years. The adjustment can only be negative if:

(a) CB_{t-1} is negative

or (b) TR_{it} is negative

or (c) $K_t^* < K_{it-1}$

On farm 8, negative b values were due to $K_t^* < K_{t-1}$. This farm was a very small hard hill country farm settled by a rehabilitated farmer and could, in this situation, have had more capital than necessary. Farm 13 had a very large positive b value in 1974/75, and larger than average b values in other years except in 1976/77 when the b value was negative. Farm 13 was characterised by very low desired investment over the data period. In 1974/75, desired investment was positive but close to zero. This together with a large opening cash balance in 1974/75 gave the very large b value. In 1976/77, $K_t^* < K_{t-1}$ on farm 13. Farm 19 had below average b values for much of the data period with a negative b value in 1976/77. Farm 19 began the data period with an opening cash deficit. This deficit increased each year, peaking in 1976/77 where it was sufficient to suggest a reduction in capital stock.

A number of farms exhibited large fluctuations in adjustment coefficients from one year to the next. These fluctuations were due in large part to the influence of transitory income. For instance, farm 20 in 1977/78 experienced a $4,066 windfall gain, to be followed by a $3,514 windfall loss in 1978/79. The adjustment coefficients increased then fell in response to these windfall gains and losses.

In the discussion of equation 7b in Section 6.6, it was shown that with zero opening cash balances and transitory incomes, an autonomous rate of net investment of 3.6 percent of desired investment would have been expected to have been carried out each year. Several farms in Table 6.6 report adjustment coefficients less than 3.6 percent. For these farms, opening cash balances were negative. The rate of net investment on these farms was therefore less than it would have been had these farms at the least had a minimum of liquidity.

6.9 Summary

This chapter developed and tested a model of net investment decision making on the survey farms. The model was based on that first developed by Waugh (1977) but modified in the light of the survey farm characteristics described in Chapter 5.

The initial model specification hypothesised net investment expenditure to result from the simultaneous solution of two processes, determination of desired capital stock and the rate of adjustment of actual capital stock to the desired level. Desired capital stock was initially assumed to be determined by the real price of capital services, Government policy and technological change. The rate of adjustment was initially assumed to be determined by opening cash balances and transitory income. Individual farm differences in net investment behaviour were initially measured by individual farm dummy variables.

This initial model was tested using ordinary least squares combining time-series and cross-section data. In the first regression the policy, transitory income and lagged capital stock were the only variables with coefficients significant at the ten percent level. On removing the real price of capital and technological change variables the remaining variables, except for opening cash balance, continued to have coefficients of the right sign and significant at the ten percent level. Because the coefficient of opening cash balance had the correct sign, did not change in size with the removal of the real price of capital and technological change variables, and was significant at about the twenty percent level, opening cash balance was included in further regressions. Inclusion of the individual farm dummy variables significantly improved the equation, indicating the presence of individual farm differences in net investment decision making unexplained by the above variables.

Candidate variables explaining individual farm differences in net investment behaviour were tested. Effective farm size, approximate farmer age and initial development state were found to explain net investment behaviour at the one, fifteen and five percent significance levels respectively. Only for farms 5 to 8 did these variables not satisfactorily explain between-farm differences.

Chapter Seven
Implications for Policy and Further Research

7.1 Objectives and method of the study

This study has investigated the process of net investment decision making on a group of New Zealand sheep and beef farmers. A review of previous theoretical and empirical research on farm investment decision making led to the study's objective, namely to test that investment decision making on New Zealand farms could be incorporated in two dimensions : the determination of a desired level of capital stock and a description of the rate of adjustment of actual capital stock to the desired level.

Quantifying these relationships was deemed of relevance to policy-makers. The period under study from 1973/74 to 1980/81 was one of considerable uncertainty to New Zealand farmers and one of considerable Government intervention in the market-place in attempting to stabilise farmers' incomes and increase output. Net (or new) farm investment was seen to be an ingredient in planned growth in output,[1] however information on net investment at the individual farm level was not available to policy-makers at the time.

A study by Laing (1982) using aggregate New Zealand farm data, had similar objectives to this study. Laing's study however failed to quantify the relationships hypothesised.[2] So as to complement the previous study by Laing, this study chose a data source at the individual farmer level, in the belief that aggregation of data ignored inter-farm differences in approaches to investment decision making.

Having decided upon some testable hypotheses and objectives, a search for a suitable data base began. The chosen data base was a sub-set of the farms surveyed by the Meat and Wool Board's Economic Service (MWBES) for their Sheep and Beef Farm Survey. Inspection of their

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1 This was discussed in Section 1.1

2 This was discussed in Section 3.3

farm records revealed that series of net investment expenditure for a set of farms could be built by augmenting dollar amounts in the farm accounts with written and verbal explanations from the MWBES Field Officers. Due to the complexity and variety of farm accounts' presentation, it was necessary to compile a farm cash flow for each financial year in order to record all the cash movements, particularly net investment.

Using a model initially developed by Waugh (1977), but supplemented with what was known about the individual survey farms,[3] a model of net investment decision making was specified. This model was tested using ordinary least squares combining time series and cross-section data. The initial model specification included individual farm dummy variables to account for cross-sectional differences in net investment decision making. Later, candidate variables hypothesised as explaining cross-section differences were included in the model.

7.2 Policy implications of the investment model

The regression results in confirming most a priori expectations, provided a useful review of the nature of farm net investment decision making over the data period. In doing so, this study may provide a guide towards future policy directed at the farm sector.

Net investment decision making on New Zealand sheep and beef farms can be viewed as incorporating two dimensions, the determination of demand for desired capital stock and adjustment of actual capital stock towards the desired level. Demand for desired capital stock per farm over the data period can be viewed as determined by Government policy measures, farm size, farmer age and initial development state. Demand for desired capital stock does not appear to be influenced by the real price of capital. Adjustment of actual capital stock to the desired level can be viewed as determined by the level of cash at the beginning of each period and windfall gains and losses in net income in the current period.

3 This was discussed in Chapter 5

For the period of study, the regression results indicated that the combined effect of policy measures succeeded in raising the desired levels of capital stock on the survey farms and therefore net investment. Differences between farms such as farm size, farmer age and initial development state were also found to influence desired capital stock. Future policy measures could be better targeted to account for such differences between farms in the policy formulation. For instance, because larger farms desire more capital, they are disadvantaged when the Rural Bank places absolute limits on loans, regardless of farm size. On the other hand, the Rural Bank policy of encouraging the settlement of young farmers is likely to result in more capital growth of the pastoral sector.

For the period of study, the regression results indicated that net investment was constrained by the availability of internal funds. Two variables, cash available at the beginning of the production period and windfall gains or losses in net income in the current period were identified as determining the rate of net investment. The size of the opening cash balance coefficient suggested that ceteris paribus, a one dollar increase in opening cash balance increased the rate at which capital stock adjusted to the extent that six cents were invested, provided the change in cash balance was within the 'normal' range.

The regression results suggested that over the data period, windfall gains or losses in net income changed the rate of net investment to the extent that from a one dollar increase in windfall gain, eleven cents were towards net investment.

The linkage between net investment and farmers' net income stream has been well known since the work of Johnson (1971). At the individual farmer level, the marginal propensity to invest of 0.06 could suggest this linkage may not be as strong as previously thought.

However, the present study used a different 'income' variable than did Johnson, and the computed marginal coefficient can be greater than (less than) the quoted value in the presence of windfall gains (losses).

7.3 A review of some problems with the investment model

The use of individual farm dummy variables as a measure of cross-sectional effects was a useful technique. However, the technique told nothing about the underlying reasons for inter-farm differences. A priori reasoning led to considering certain variables but they could be proxies for other variables. Farmer age for instance could be a proxy for satisficing behaviour. A survey of individual farmers could better identify inter-farm differences in farm investment decision making.

The nature of capital inputs limited the ability of the model to predict the amount of net investment. Much net investment on the survey farms was observed to be 'lumpy', and the investment model could not predict the size of these types of expenditure.

The measurement of desired net investment was partly determined by the level of existing capital stocks at the beginning of each decision period. Reliance was placed on the MWBES valuation of farm capital as a measure of the capital services available on the farm. However, such an aggregation may not have represented the actual flow of capital services on each farm, and in particular what capital services were lacking. It was known for instance that Farm 5 lacked a woolshed, but the capital aggregation could not identify this. Similarly, farms described as 'attractive units' may have had capital inputs in place that did not increase the flow of capital services. Without the theoretical and empirical framework to develop a more accurate measure of the flow of capital services the available data was accepted as the only alternative measure.

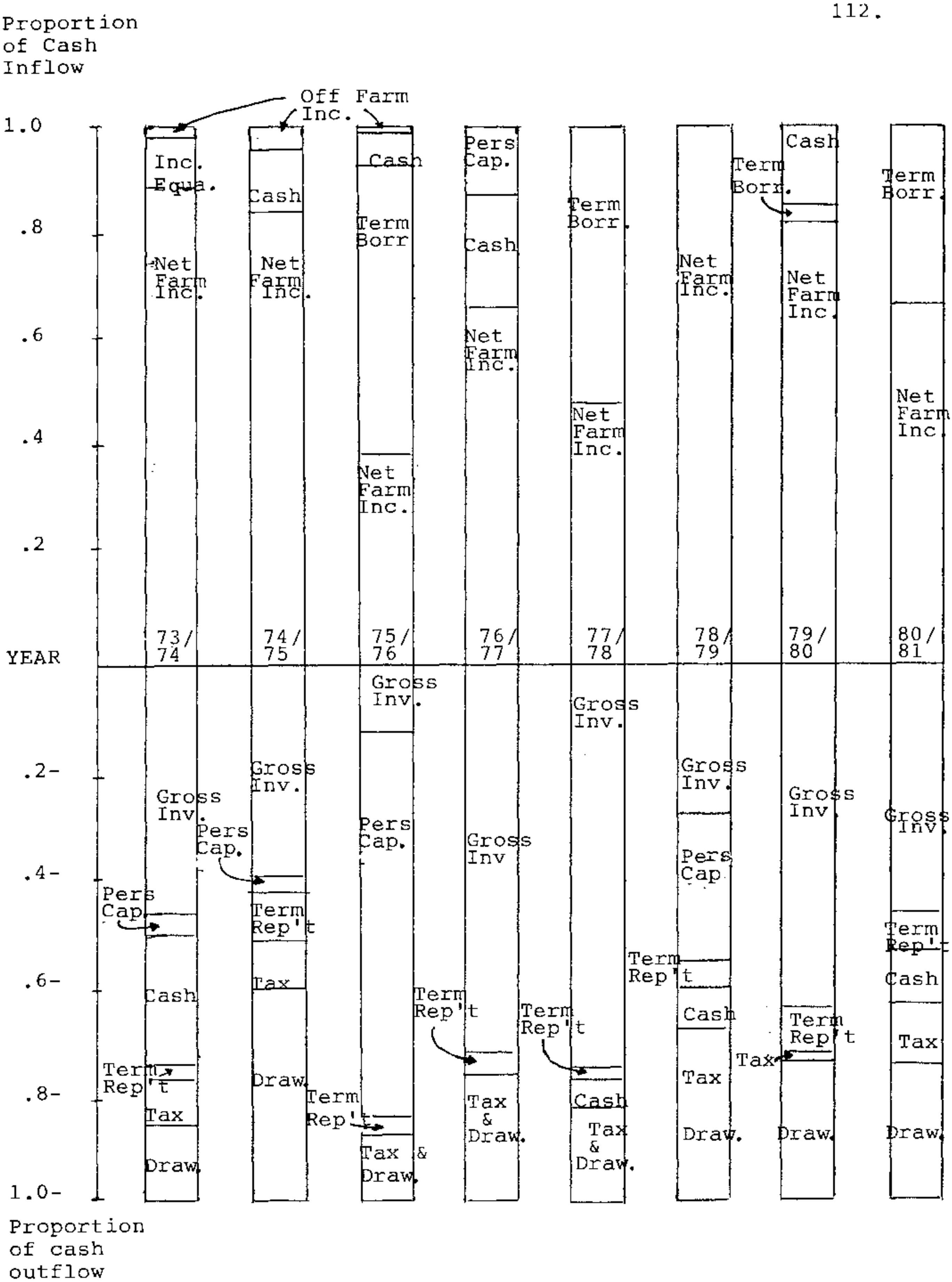

Figure 7.1: Source and Use of Funds as a Proportion of Total Cash Inflow and Outflow on Farm 5

On viewing the cash flows of the survey farms, it was apparent that the investment decision was only one of several decisions simultaneously considered by the farmer. In particular, there appeared to be a trade-off between investment expenditure on the farm and expenditure on other more personal securities. The latter, termed personal capital, included off farm investments, expenditure on personal vehicles, and expenditure on the homestead. An illustration of this trade off is presented in Figure 7.1. On Farm 5, the source and disposal of cash funds as a proportion of total cash used was particularly low in the first two years of the data period, years in which a new homestead was constructed. Despite the homestead construction being financed largely by term borrowing, it appeared that this activity plus farm investment activity could not proceed simultaneously. In other years, drawings, tax, cash accumulation and further personal capital expenditure and term loan repayments competed in varying degree for the total use of funds.

These alternative uses of funds reflected the decisions the farmer had over the production and consumption possibilities available to him. A complete investment model therefore would need to account for the simultaneous nature of all these decisions.

7.4 Further research possibilities on farm investment

Whilst the investment model provided a partial explanation of farmers net investment decision making, the study, being at the farmer level, could have explored other inter-farm differences, had the data been available. This data could be obtained through appropriately designed farmer surveys and could be an avenue for further research.

Problems in the measurement of capital were encountered in the research process. As a result, the measurement of a key variable in the investment model, the value of actual capital stock, may be in error. Further research into the disaggregation of capital, the productivity of particular capital inputs, and the time pattern of how these capital services decay would provide an empirical base for more accurate measurement of the actual level of capital stock on farms.

Given the interdependencies of the consumption-investment decisions apparent on farms, an investment model that combined these interdependencies could provide a more complete explanation of the investment process on farms. The behavioural approach begun by Zwart and Laing (1983) was an improvement in this direction. The farm survey data could provide for a more complete empirical investigation of the behavioural model.

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APPENDIX 1:

A DESCRIPTION OF EACH FARM IN THE SAMPLE:

(A) Farms located in the West Coast North Island region on hill type land class

Farm 1: Easy country in a well developed state. owner aged.

Farm 2: Easy country with good pastures but lacking farm improvements. Owner less than forty years old.

Farm 3: Easy country in a well developed state. Owner less than forty years of age.

Farm 4: Easy country in a well developed state. Farmed by two brothers in partnership both aged around forty.

Farm 5: Easy country with no woolshed, poorly fenced and tracked. Recent purchaser aged less than forty.

Farm 6: Easy country in a well developed state. Son purchased off father end of 1975/76

(B) Farms located in the West Coast North Island region on hard hill type land class

Farm 7: Moderate to steep contour in a reasonably developed state. Run in conjunction with small fattening unit close to town. Recent purchaser aged less than forty.

Farm 8: Difficult farm in an isolated area, having broken terrain and poor internal access. A rehabilitation farm, owner aged over forty.

(C) Farms located in the Wairarapa Region on hill type land class

Farm 9: Easy country in a reasonable state of development. Son purchased farm off owner end of 1974/75.

Farm 10: Easy country in a well developed state. Owner recent purchaser aged less than forty.

Farm 11: In a rundown state being brought back into production. Son purchased off father end of 1976/77.

Farm 12: Easy country in a well developed state. Owner deceased and managed part-time.

Farm 13: Easy country in a well developed state. Owner aged over forty.

(D) Farms located in the Wairarapa Region on hard hill type land class

Farm 14: Was badly reverted but being brought back into production. Farm run as a partnership between father and son.

Farm 15: Was badly reverted but being brought back into production. Farmed as partnership from end of 1975/76 by two brothers who took over from father

Farm 16: Very large farm in native grasses and large area of bush. Owner recent purchaser aged less than forty.

Farm 17: Steep contoured farm in a largely undeveloped state. Owner aged less than forty.

<u>Farm 18</u>: Was badly reverted but being brought back into production. Owner recent purchaser aged less than forty.

<u>Farm 19</u>: An old family farm in a good state of development. Owner aged over forty.

<u>Farm 20</u>: Was badly reverted but being brought back into production. Owner aged over forty.

<u>Farm 21</u>: Old family farm in a good state of development. Owner aged over forty.

APPENDIX 2:

A DESCRIPTION OF EACH DATA VARIABLE

This data is held on a computer file at Massey University and can be obtained by contacting the Head of the Agricultural Economics and Farm Management Department. Variables 1 to 23 were obtained from the Meat and Wool Board's Economic Service Data File.

1. Farm Identification (ID)
   A unique identification of each farm in the data file. First digit refers to the Farm Type of the farm. In this file 4 refers to "Hill" farm type, 3 refers to "Hard Hill" farm type. The second digit refers to the Region the farms belongs to. In this file 4 refers to the "West Coast" region, 5 refers to the "Wairarapa" region. The remaining four digits identify an individual farm in a region and farm type group.

2. Year (YR)
   Refers to the financial year ended to which the record refers.

3. Effective area (HA)
   Total area less waste only. Includes areas occupied by buildings, yards and plantations.

4. Sheep stock units (SSU)

5. Cattle stock units (CSU)
   Variables 4 and 5 based on the stock unit conversion ratios recommended by Coop, in "NZ Agricultural Science" Vol. 1, No. 3, 1965.

6. Labour (LAB)
   Man years of owners, permanent and casual labour but excluding contract work such as shearing, fencing and scrubcutting.

7. Lamb production (LB)

8. Mutton production (MU)

9. Beef production (BEEF)

Variables 7, 8 and 9 are weight (kg) of total sales of each meat class, adjusted by the weight of changes in livestock numbers using standard weights for each class of animal in the opening and closing stocks.

10. Wool production (TOTWP)

Weight (kg) of wool produced by adjusting sales (kg) by estimates of wool on the backs of sheep purchased and sold during the year and adjusting for stocks unsold.

11. Lambing percentage (LAMBING)

Lambs tailed as a percentage of ewes mated.

12. Calving percentage (CALVING)

Calves marked as a percentage of cows mated, adjusted for sale or purchase of in-calf cows.

13. Fertiliser applied (FERTT)

Weight (tonnes) of all fertilisers applied to the farm area.

14. Fertiliser cost (FERT)

Materials cost of all fertiliser applied. Excludes capital fertiliser when associated with land development when it is included in variable (LANDEV).

15. Interest (INT)

Interest cost on long and short term debt.

16. Land and improvements value (LAIMP)

Capital value of the farm based on information supplied by the Valuation Department as at 1 July each year.

Includes the values of land, buildings and improvements, the separate valuations of which are not available.

17. Plant and machinery value (PLMA)
Book value of plant and machinery taken directly from the balance sheet.

18. Sheep value (SH)

19. Cattle value (CA)
Sheep and cattle are valued at current prices by taking closing livestock numbers and applying current market values.

20. Farm value (FMCAP)
Value of farm by summing variables 16, 17, 18 and 19.

21. Enterprise value (TOTCAP)
Estimate of the total worth of the farm by adding to FMCAP the value of the homestead and other assets not previously included.

22. Fixed liabilities (FIXLI)
Taken from the balance sheet, these are the balances for mortgages and loans of a greater than one year term.

23. Current liabilities (CURLI)
Taken from the balance sheet, these are the short term debts including bank, stock and station agent overdraft, and sundry creditors (including provision for tax).

Variables 24 to 36 were obtained from the cash flow of each set of farm accounts. This data is held on computer file at Massey University.

Variables 24 to 36 describe the cash inflow variables.

24. Total cash receipts (TOTREC)
Total receipts ($) from farm trading activity. This is separated into sheep, cattle, wool and other cash receipts.

25. Sheep receipts (SHEREC)
Cash receipts from the sale of sheep and lambs.

26. Cattle receipts (CATREC)
Cash receipts from the sale of cattle.

27. Wool receipts (WOOREC)
Cash receipts from the sale of wool.

28. Other receipts (OTHREC)
Cash receipts from other farm trading activities. Generally included income from hay or barley sales, but also included other items like rent of airstrip or buildings.

29. Off farm income (OFFIN)
Income from off farm investments.

30. Long term borrowing (LTB)
Additional mortgages and loans of greater than one year term.

31. Short term borrowing (STB)
Increases in cash current liabilities including bank and stock and station agent overdraft and sundry creditors but excluding provision for tax and intra farm transfers.

32. Cash decrease (CADEC)
Decrease in current assets including reduction in bank, stock and station accounts and sundry debtors.

33. Sale of personal capital (CAPIN + PECAPIN)
Receipts from the sale of off farm investments and private vehicles.

34. Income equalisation withdrawal (IEWD)
Cash withdrawals from the income equalisation account.

35. Plant sales (PLSA)
Cash receipts from the sale of farm plant.

36. Vehicle sales (VESA)
Cash receipts from the sale of farm vehicles.

Variables 37 to 69 describe the cash outflow variables. They belong to four sets:

Working Capital Variables,
Capital Account Variables
Farm Investment Variables,
Personal Expense Variables.

Variables 37 to 46 describe the working expense variables.

37. Total operating costs (TOTOP)
Sum of cash operating expenses as detailed in the farm working account. As well as including interest (INT) and fertiliser (FERT) costs TOTOP includes;

38. Sheep purchase (SHEPUR)
Cash expenditure on sheep purchase.

39. Cattle purchase (CATPUR)
Cash expenditure on cattle purchase.

40. Farm improvement replacement (FNGCOST)
Cash expenditure on replacement of farm improvements.

41. Weed and pest control (WECOST)
Cash expenditure on weed and pest control.

42. <u>Tracks and water supply (TRWSCOST)</u>
Cash expenditure on tracks and water supply.

43. <u>Drainage (DRAINCOST)</u>
Cash expenditure on farm drains.

44. <u>Farm buildings (BLGCOST)</u>
Cash expenditure on farm buildings.

45. <u>Plant (PLANTCOST)</u>
Cash expenditure on farm plant.

46. <u>Vehicles (VEHCOST)</u>
Cash expenditure on farm vehicles.

Variables 47 to 50 describe personal expense variables.

47. <u>Taxation (TAX)</u>
Actual tax paid over the financial year.

48. <u>Drawings (DRAW)</u>
Actual cash paid to owner(s) who have a claim to a share of farm income. Includes cash paid to owner operators as drawings, to family members for casual work, to partners or shareholders as drawings or salary, disbursements to trust beneficiaries and cash expenditure on the homestead and personal car.

49. <u>Personal capital (TOTPECAP)</u>
Cash spent on personal capital. Includes cash paid for new or replacement personal car, major homestead renovation or construction, and off farm investment.

50. <u>Savings (SAVING)</u>
That part of personal capital expenditure (TOTPECAP) that is off farm investment.

Variables 51 to 54 describe the capital account cash outflow variables.

51. <u>Term loan repayments (LTRE)</u>
    Cash outgoings for principal repayments on mortgages and loans of greater than one year term.

52. <u>Short term repayments (STRE)</u>
    Cash outgoings reducing short term liabilities.

53. <u>Cash increase (CAINC)</u>
    Cash increase in current accounts.

54. <u>Income equalisation deposit (IED)</u>
    Cash deposited in the income equalisation account.

Variables 55 to 63 describe the cash outflow on net investment and replacement investment on assets described as fixed assets in the accounts.
Replacement investment variables.

55. <u>Plant replacement (PLRE)</u>
    Cash paid for the replacement of plant.

56. <u>Vehicle replacement (VERE)</u>
    Cash paid for the replacement of farm vehicles.

57. <u>Building replacement (BLDGRE)</u>
    Cash paid for the replacement of farm buildings.

58. <u>Total fixed asset replacement (TOTFARE)</u>
    Sum of variables 55, 56 and 57.

Net investment variables.

59. <u>Plant additions (PLAD)</u>
    Cash paid for additions to farm plant.

60. Vehicle additions (VEAD)
Cash paid on additions to farm vehicle stock.

61. Building additions (BLDGAD)
Cash paid on additional farm buildings. Includes covered yards but excludes expenditure on homestead.

62. Land additions (LAAD)
Cash paid for farmland aggregated to the home farm.

63. Total fixed asset additions (TOTFAAD)
Sum of variables 59, 60, 61 and 62.

Variables 64 to 69 describe net investment on farmland improvement.

64. Land improvements (TOTIMP)
Cash paid on additional farm improvements other than on fixed assets. Includes:

65. Land development (LANDEV)
Cash paid on bringing additional land into production. Includes scrubcutting, land clearing, oversowing and capital fertiliser.

66. Fencing development (FNGDEV)
Cash paid on additional fences and yards. Includes expenditure on fertiliser bins but excludes expenditure on covered yards (included in BLDGAD).

67. Water supply development (WSDEV)
Cash paid for provision of additional water to livestock.

68. Access development (ACCESDEV)
Cash paid on additional tracking, bridges and roading on the farm.

69. Drainage development (DRAINDEV)
Cash paid for additional farmland drainage.

70. Opening cash balance (CASHB)
The net cash balance in the current accounts of the balance sheet.

Variables 71 to 76 describe those cash inflow and cash outflow variables associated with those farms that changed ownership over the data period. Apart from altering interest and principal repayments, such expenditure did not affect normal trading cash flows so were recorded separately.

71. Farm purchase borrowing (BORROWING)
All borrowing associated with the farm purchase transaction.

72. Plant purchase (PLANTPUR)
Cost of plant on farm purchase.

73. Vehicle purchase (VEHPUR)
Cost of vehicles on farm purchase.

74. Land purchase (LANDPUR)
Cost of farmland on farm purchase.

75. Homestead purchase (HSTEADPUR)
Cost of homestead on farm purchase.

76. Stock purchase (STOCKPUR)
Cost of livestock on farm purchase.

APPENDIX 3:

PRICES INDICES USED IN REGRESSION MODEL

1. Monetary price index

Financial variables were deflated to 1973/74 base using the index calculated as:

(Exp/GI* transposed prices paid index)
   + (NI/GI * transposed CPI),

where: Exp = expenditure per sheep farm (source MWBES)

GI = gross income per sheep farm (source MWBES)

NI = net income per sheep farm (source MWBES)

CPI = consumers price index, December Year (source Statistics Department)

Prices paid index = sheep/beef farm prices paid index (source MWBES)

This index was calculated as:

1973/74	1.000
1974/75	0.903
1975/76	0.783
1976/77	0.660
1977/78	0.582
1978/79	0.528
1979/80	0.439
1980/81	0.366

The financial variables 29-34, 47-54, 70 in Appendix 2 were deflated by the monetary price index in order to measure the purchasing power of these variables.

2. Farm receipts

Farm receipts (TOTREC) were deflated by the MWBES Prices Received Index transposed to 1973/74 base.

This index was used to de-trend the farm receipts series.
This index was calculated as follows:

1973/74	1.000
1974/75	1,405
1975/76	0.940
1976/77	0.745
1977/78	0.782
1978/79	0.632
1979/80	0.532
1980/81	0.493

3. Farm operating costs

Farm operating costs (TOTOP) were deflated by the Statistics Department Sheep Farms Cost Index transposed to 1973/74 base. This index was used to de-trend the farm operating cost series.
This index was calculated as:

1973/74	1.000
1974/75	0.890
1975/76	0.799
1976/77	0.678
1977/78	0.599
1978/79	0.546
1979/80	0.437
1980/81	0.352

4. Fertiliser cost

Fertiliser cost was deflated by the Statistics Department Fertiliser Price Index transposed to 1973/74 base. This index was used to de-trend the fertiliser cost base data series.
This index was calculated as:

1973/74	1.000
1974/75	0.954
1975/76	0.960
1976/77	0.705
1977/78	0.646
1978/79	0.665
1979/80	0.404
1980/81	0.290

5. Farmland values

Farmland values deflated by Valuation Department Grazing Land Price Index transposed to 1973/74 base. This index was used to obtain a volume measure of capital stock. This index was calculated as:

1973/74	1.000
1974/75	0.888
1975/76	0.825
1977/78	0.825
1976/77	0.717
1977/78	0.637
1978/79	0.506
1979/80	0.405
1980/81	0.256

6. Land improvement replacement, land development, fencing additions, water supply, access and drainage additions

This development expenditure was deflated by the Statistics Department Land Development Capital Price Index transposed to 1973/74 base. This index was used to obtain volume measures of these capital inputs This index was calculated as:

1973/74	1.000
1974/75	0.857
1975/76	0.788
1976/77	0.659
1977/78	0.577

1978/79	0.529
1979/80	0.419
1980/81	0.336

7. Buildings

Building replacement and additions were deflated by the Statistics Department Farm Buildings Capital Price Index transposed to 1973/74 base. This index was used to obtain volume measures of those data series. This index was calculated as:

1973/74	1.000
1974/75	0.865
1975/76	0.740
1976/77	0.672
1977/78	0.536
1978/79	0.466
1979/80	0.402
1980/81	0.328

8. Equipment

Equipment sales and purchases were deflated by the Statistics Department Tractor and Farm Machinery Capital Price Index transposed to 1973/74 base. This index was used to obtain volume measure of those data series. This index was calculated as:

1973/74	1.000
1974/75	0.811
1975/76	0.605
1976/77	0.465
1977/78	0.406
1978/79	0.369
1979/80	0.318
1980/81	0.274

9. Capital Service Prices in New Zealand Farming

Year	Capital Service Price		
	Land Improvements	Building	Equipment
60	0.130	0.131	0.325
61	0.129	0.134	0.341
62	0.125	0.133	0.320
63	0.128	0.137	0.313
64	0.129	0.140	0.308
65	0.121	0.139	0.300
66	0.110	0.131	0.292
67	0.104	0.126	0.295
68	0.097	0.123	0.322
69	0.084	0.118	0.334
70	0.077	0.102	0.337
71	0.076	0.106	0.375
72	0.073	0.109	0.379
73	0.079	0.111	0.406
74	0.066	0.094	0.381
75	0.074	0.104	0.467
76	0.089	0.128	0.683
77	0.083	0.120	0.677
78	0.053	0.087	0.760
79	0.086	0.130	0.855
80	0.083	0.112	0.955
81	0.089	0.112	1.074

Source: Economics Department, Victoria University, personal Communication.

APPENDIX 4:

VARIABLES USED IN THE REGRESSION ANALYSIS

4.1 Variables unique to each farm

FARM 1

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	97	1151	3027	1536	2495	3909	100
HAP_{t-1}	0	0	0	245	245	245	245
CB_{t-1}	7039	22508	26113	20273	19062	18969	8751
TR_t	0	0	0	-650	0	2684	-2773
TRN_t	0	0	0	0	0	2684	0
K_{t-1}	159770	132207	146653	151996	147607	161424	163390
HA_t	245	245	245	245	245	245	245
AGE_i	70	70	70	70	70	70	70

FARM 2

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	5084	5159	5112	661	4274	3436	2869
HAP_{t-1}	0	0	0	874	874	845	845
CB_{t-1}	-9357	-13717	-13121	-2835	-12925	-5182	-12768
TR_t	5744	-2822	1305	2680	0	0	0
TRN_t	0	-2822	0	0	0	0	0
TRP_t	5744	0	1305	2680	0	0	0
K_{t-1}	394624	319084	376560	409077	398962	374118	402988
HA_t	874	874	874	874	874	845	845
AGE_i	35	35	35	35	35	35	35

FARM 3

I_t	2333	5310	5778	4242	4746	2072	867
HAP_{t-1}	0	0	0	227	227	240	240
CB_{t-1}	9633	7815	8244	8525	6178	12847	10528
TR_t	0	2808	0	0	4159	0	0
TRN_t	0	0	0	0	0	0	0
TRP_t	0	2808	0	0	4159	0	0
K_{t-1}	153806	137749	143614	151168	143201	140457	136461
HA_t	227	227	227	227	240	240	240
AGE_i	40	40	40	40	40	40	40

FARM 4

I_t	315	0	1882	367	8341	6392	6432
HAP_{t-1}	0	0	0	417	417	431	431
CB_{t-1}	40664	39824	35652	31961	41777	19785	19176
TR_t	0	0	0	4349	-21657	0	0
TRN_t	0	0	0	0	-21657	0	0
TRP_t	0	0	0	4349	0	0	0
K_{t-1}	270892	248213	273866	271131	235707	244321	313964
HA_t	417	417	417	417	417	431	431
AGE_i	45	45	45	45	45	45	45

FARM 5

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	648	3128	14531	24125	2265	11111	1975
HAP_{t-1}	0	0	0	328	344	367	373
CB_{t-1}	5590	3905	27439	14919	15459	20542	13327
TR_t	0	0	0	5285	-1502	0	0
TRN_t	0	0	0	0	-1502	0	0
TRP_t	0	0	0	5285	0	0	0
K_{t-1}	135189	115597	130015	163036	139525	140951	173605
HA_t	380	380	305	328	344	367	373
AGE_i	34	34	34	34	34	34	34

FARM 6

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	543	3037	11835	10381	10905	7216	4210
HAP_{t-1}	0	0	0	279	279	316	316
CB_{t-1}	25438	20753	1734	12346	16934	-1604	5352
TR_t	0	-5718	0	0	-4254	11053	0
TRN_t	0	-5718	0	0	-4254	0	0
TRP_t	0	0	0	0	0	11053	0
K_{t-1}	198953	174242	144215	146053	161753	128488	210815
HA_t	316	279	279	279	279	316	316
AGE_i	55	55	33	33	33	33	33

FARM 7

I_t	3063	19005	1279	1543	5786	4301	767
HAP_{t-1}	0	0	0	677	677	677	677
CB_{t-1}	2606	-7822	-7501	-8841	-6877	5526	11558
TR_t	1587	1012	0	3363	5840	0	0
TRN_t	0	0	0	0	0	0	0
TRP_t	1587	1012	0	3363	5840	0	0
K_{t-1}	270212	225496	274440	313402	350518	370992	393748
HA_t	659	677	677	677	677	677	677
AGE_i	33	33	33	33	33	33	33

FARM 8

I_t	377	52	112	538	633	1886	618
HAP_{t-1}	0	0	0	265	265	265	265
CB_{t-1}	7217	7927	11935	14549	12353	16925	18598
TR_t	-2172	0	0	0	259	0	-4429
TRN_t	-2172	0	0	0	0	0	-4429
TRP_t	0	0	0	0	259	0	0
K_{t-1}	107907	89951	98847	100918	100650	95684	112848
HA_t	244	265	265	265	265	265	265
AGE_i	50	50	50	50	50	50	50

FARM 9

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	446	1799	872	235	2354	1981	912
HAP_{t-1}	0	0	0	299	299	299	299
CB_{t-1}	-2738	-6340	369	-1919	-712	23	1845
TR_t	0	1356	0	0	3413	0	-921
TRN_t	0	0	0	0	0	0	-921
TRP_t	0	0	0	0	3413	0	0
K_{t-1}	126074	104445	116729	124239	116963	137240	134166
HA_t	299	299	299	299	299	299	299
AGE_i	55	33	33	33	33	33	33

FARM 10

I_t	1575	1519	4796	1846	695	6431	1397
HAP_{t-1}	0	0	0	386	386	386	386
CB_{t-1}	9833	4513	8081	7960	-383	9474	10656
TR_t	0	2185	0	-15	0	2040	-1649
TRN_t	0	0	0	-15	0	0	-1649
TRP_t	0	0	0	0	0	2040	0
K_{t-1}	221198	182455	192646	203734	189596	210885	212140
HA_t	386	386	386	386	386	386	386
AGE_i	55	55	55	55	55	55	55

FARM 11

I_t	368	935	3192	2172	1859	3245	3243
HAP_{t-1}	0	0	0	295	304	304	304
CB_{t-1}	8053	8218	10459	5196	-283	2672	590
TR_t	0	0	-5619	0	2498	0	5026
TRN_t	0	0	-5619	0	0	0	0
TRP_t	0	0	0	0	2498	0	5026
K_{t-1}	94677	84188	108219	103457	110577	112931	123845
HA_t	295	295	295	295	304	304	304
AGE_i	55	55	55	33	33	33	33

FARM 12

I_t	0	0	0	1254	1629	0	764
HAP_{t-1}	0	0	0	175	175	175	175
CB_{t-1}	-5658	-859	-2164	-2149	1804	-4998	797
TR_t	8925	-6831	0	789	0	0	0
TRN_t	0	-6831	0	0	0	0	0
TRP_t	8925	0	0	789	0	0	0
K_{t-1}	115031	96878	108807	114617	109179	115688	123134
HA_t	175	175	175	175	175	175	175
AGE_i	70	70	70	70	70	70	70

FARM 13

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	272	1241	1980	1504	7477	1448	577
HAP_{t-1}	0	0	0	470	470	470	470
CB_{t-1}	24087	16997	22600	16089	15161	14507	21459
TR_t	0	3382	-3331	0	0	7015	0
TRN_t	0	0	-3331	0	0	0	0
TRP_t	0	3382	0	0	0	7015	0
K_{t-1}	286338	251183	295895	302739	283585	297733	304050
HA_t	470	470	470	470	470	470	470
AGE_i	48	48	48	48	48	48	48

FARM 14

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	203	938	1349	3677	148	1638	520
HAP_{t-1}	0	0	0	344	344	344	344
CB_{t-1}	4623	1226	7498	10082	1673	6312	1001
TR_t	-294	2672	504	-3219	0	0	0
TRN_t	-294	0	0	-3219	0	0	0
TRP_t	0	2672	504	0	0	0	0
K_{t-1}	131909	116958	129829	155906	136589	144178	148756
HA_t	344	344	344	344	344	344	344
AGE_i	50	50	50	50	50	50	50

FARM 15

I_t	1732	552	2878	2385	4133	8425	4606
HAP_{t-1}	0	0	0	433	433	433	433
CB_{t-1}	2162	841	-3563	1956	34	1805	-4153
TR_t	0	-10612	11725	0	0	0	0
TRN_t	0	-10612	0	0	0	0	0
TRP_t	0	0	11725	0	0	0	0
K_{t-1}	175214	141868	176137	169565	152268	203018	186581
HA_t	417	417	433	433	433	433	433
AGE_i	55	55	30	30	30	30	30

FARM 16

I_t	3150	16405	3655	12253	14863	21003	18798
HAP_{t-1}	0	0	0	1497	1497	1582	1582
CB_{t-1}	-42197	-43181	-1826	-9472	-2035	-9478	14104
TR_t	13124	6836	-10237	0	0	15514	0
TRN_t	0	0	-10237	0	0	0	0
TRP_t	13124	6836	0	0	0	15514	0
K_{t-1}	436277	350592	393447	397500	410206	479597	473113
HA_t	1497	1497	1497	1497	1497	1582	1582
AGE_i	33	33	33	33	33	33	33

FARM 17

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	3762	1686	4056	5543	2480	4397	3702
HAP_{t-1}	0	0	0	457	470	470	470
CB_{t-1}	-9410	-15006	-3524	-6051	-17734	-15288	-9823
TR_t	0	6179	0	0	0	1409	0
TRN_t	0	0	0	0	0	0	0
TRP_t	0	6179	0	0	0	1409	0
K_{t-1}	103190	85205	114797	123133	111629	138414	152054
HA_t	457	457	457	457	470	470	470
AGE_i	40	40	40	40	40	40	40

FARM 19

I_t	1559	2709	3720	7516	227	3438	2393
HAP_{t-1}	0	0	0	830	830	830	830
CB_{t-1}	-197	-16598	-14117	1979	-3681	4461	21336
TR_t	-6258	2697	1586	0	0	8479	0
TRN_t	-6255	0	0	0	0	0	0
TRP_t	0	2697	1586	0	0	8479	0
K_{t-1}	379321	317842	406017	420770	382162	431141	428506
HA_t	830	830	830	830	830	830	830
AGE_i	48	48	48	48	48	48	48

FARM 18

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	328	5611	131	2044	3646	1820	14004
HAP_{t-1}	0	0	0	830	830	830	906
CB_{t-1}	-8122	-13938	-5084	2628	-20812	11702	7561
TR_t	0	0	0	-15250	14947	0	0
TRN_t	0	0	0	-15250	0	0	0
TRP_t	0	0	0	0	14947	0	0
K_{t-1}	343208	282812	333423	346235	321077	362829	345095
HA_t	830	830	830	830	830	830	906
AGE_i	40	40	40	40	40	40	40

FARM 20

I_t	864	1648	2101	14170	1892	856	1166
HAP_{t-1}	0	0	0	315	315	315	315
CB_{t-1}	11181	7795	3230	7704	8424	3299	1907
TR_t	0	0	0	4067	-3514	0	315
TRN_t	0	0	0	0	-3514	0	0
TRP_t	0	0	0	4067	0	0	315
K_{t-1}	129378	109684	139833	140152	121983	138469	142687
HA_t	315	315	315	315	315	315	315
AGE_i	55	55	55	55	55	55	55

FARM 21

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
I_t	1118	6411	642	2947	4415	4448	948
HAP_{t-1}	0	0	0	310	310	310	310
CB_{t-1}	11745	11029	4980	6933	8230	2615	2374
TR_t	0	0	678	0	-3365	0	5386
TRN_t	0	0	0	0	-3365	0	0
TRP_t	0	0	678	0	0	0	5386
K_{t-1}	159561	133930	157291	169161	155520	173705	174886
HA_t	310	310	310	310	310	310	310
AGE_t	44	44	44	44	44	44	44

4.2 Variables common to all survey farms each year

Year	74/75	75/76	76/77	77/78	78/79	79/80	80/81
PC_{t-1}	.1686	.2456	.1708	.1372	.1275	.1312	.1686
T	1	2	3	4	5	6	7

4.3 Variables the same for each survey farm each year

Variable / Farm	Dev i,74	R1	T1	R1T1	R1T2	R2T1
1	652	1	1	1	0	0
2	452	1	1	1	0	0
3	678	1	1	1	0	0
4	650	1	1	1	0	0
5	370	1	1	1	0	0
6	630	1	1	1	0	0
7	410	1	0	0	1	0
8	407	1	0	0	1	0
9	422	0	1	0	0	1
10	573	0	1	0	0	1
11	339	0	1	0	0	1
12	657	0	1	0	0	1
13	609	0	1	0	0	1
14	383	0	0	0	0	0
15	420	0	0	0	0	0
16	291	0	0	0	0	0
17	234	0	0	0	0	0
18	414	0	0	0	0	0
19	457	0	0	0	0	0
20	426	0	0	0	0	0
21	515	0	0	0	0	0