



THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Research Commons

<http://researchcommons.waikato.ac.nz/>

Research Commons at the University of Waikato

Copyright Statement:

The digital copy of this thesis is protected by the Copyright Act 1994 (New Zealand).

The thesis may be consulted by you, provided you comply with the provisions of the Act and the following conditions of use:

- Any use you make of these documents or images must be for research or private study purposes only, and you may not make them available to any other person.
- Authors control the copyright of their thesis. You will recognise the author's right to be identified as the author of the thesis, and due acknowledgement will be made to the author where appropriate.
- You will obtain the author's permission before publishing any material from the thesis.

ACKNOWLEDGEMENTS

I would like to thank Professor A.J.L. Catt, my supervisor, for his help and encouragement in this project. Thanks are also extended to all staff and students in the Economics Department of the University of Waikato who have given assistance during the year.

I am also very grateful to the Economics Department of the Reserve Bank of New Zealand for giving access to their facilities. In particular I would like to thank those members of the Research Section who gave up valuable time to assist with my work, and who generously shared the knowledge and experience accumulated in their study of investment.

A B S T R A C T

In this study an attempt is made to construct a model explaining quarterly investment in plant and machinery in the New Zealand economy, with a view to providing a basis for forecasting investment expenditures. A survey of theory and econometric models reveals that in the more successful overseas models the principle determinants of investment expenditures are changes in demand as reflected output changes, the capital stock, which gives an indication of existing capacity and determines replacement requirements, and also factors affecting the cost of capital equipment. These factors form the basis of the theory of investment behaviour. However it is found that the pure theoretical framework, although useful, does not provide a complete explanation of investment in New Zealand, and that such factors as import controls and other exogenous influences affect investment in this country.

The final model purports to explain ninety three per cent of the variation in investment expenditures and is statistically sound. This was considered a good result in view of the data problems encountered. Although the model is not entirely satisfactory the equation performed reasonably well in ex-poste forecasts which suggests that with some improvements, particularly of some of the data series, it could provide a useful indication of the effects of policy measures on investment.

List of Tables

	Page
TABLE I -- Results from the Basic Neo-Classical Model	52
TABLE II -- Results from the Extended Neo- Classical Model	53
GRAPH I -- The Extended Neo-Classical Model	60
GRAPH II -- The Extended Neo-Classical Model with Seperate Lag Structure	61

TABLE OF CONTENTS

	Page
Acknowledgements	i
Abstract	ii
List of Tables	iii
Table of Contents	iv
1. Introduction	1
2. The Role Of Investment Expenditures In A Macro Economic Model	4
3. The Neo-Classical Theory Of Investment Behaviour	10
4. The Accelerator Principle	15
5. The Effect of Capacity Utilisation and the Cost of Funds on the Accelerator Mechanism	18
6. Replacement Investment	26
7. Lag Structures	28
8. A Survey of Econometric Models	32
9. The Construction of a New Zealand Model	44
10. Data	54
11. Ex-poste Forecasts	58
12. Conclusion	62
Data Appendix	64
Bibliography	

1. INTRODUCTION

The objective of this paper is to construct an equation to explain private investment in plant and equipment in the New Zealand economy. For this purpose use will be made of work done to explain investment in other countries, notably the United States and Australia, and of the Reserve Bank of New Zealand's work on investment in New Zealand.

Because of the large number of different econometric models which have been constructed and the different theories and assumptions from which they are derived, it will be impossible to test all, or even a very comprehensive range of those available. Bearing this in mind the first section of the paper will broadly cover the current theories and controversies, and their historical origins, with a view to eliminating those theories and models which would not be appropriate for an aggregate quarterly model of the New Zealand economy.

In the construction of an econometric model considerable problems are envisaged, the primary one being to find the best compromise between realistic specification of economic theory and mathematical expediency which must be influenced by the availability of data suitable for examination by regression analysis. The tools available for empirical verification are crude, and the problems involved in the calculation of a single equation model are considerable; however these are multiplied when these equations are incorporated in a general equilibrium model. Because of the mathematical problems arising from the use of economic data, it is often necessary to constrain

the values of parameters in some way; this practise brings in the danger of the model becoming unrealistic in order to obtain desirable mathematical properties. This compromise is unfortunate but often necessary.

A further problem arises from the fact that much of the theory has been developed to explain the investment behaviour of a single firm or industry. There are considerable theoretical difficulties in the way of producing an aggregate investment model, and consequently any results must be regarded with caution. In any aggregate model it is necessary to make generalisations which may be of doubtful validity. For example if a linear relationship between investment and a number of variables is postulated it is likely that any relationship, even if it is significant will be very imperfect, which makes it impossible to show with any high degree of confidence that a strict causal relationship exists. This being the case it is necessary to limit the scope of the model by, in many cases highly restrictive assumptions, the breakdown of which could explain the imperfect relationship. With the above difficulties the scope of the model must be limited to its real usefulness. The primary objective of a macro-economic model is to forecast, in the relatively short term (at the most five years) changes in economic variables. In performing this limited technical role a model can be very useful, however attempts to imply more generally applicable conclusions about social and economic behaviour should be viewed with caution.

However while aggregate models have a number of weaknesses they do have advantage over firm and industry models. For example in a highly aggregated model, echo effects resulting from high investment in a particular year, in a particular industry, which can be a problem

with industry models, do not present a problem in aggregate models because of the greater tendency for random errors to cancel out. So assuming that there are no major exogenous catastrophies such as a war the data will tend to follow relatively stable trends, which will mean that replacement investment can safely be characterised as being proportional to the capital stock.

The second section of the paper will be concerned with the construction of an actual model according to the conclusions reached in the first section. Finally in concluding an attempt will be made to reconcile the results obtained from the model with the discussion in the first section.

2. THE ROLE OF INVESTMENT EXPENDITURE IN A MACRO-MODEL

The role of investment expenditure is one of the central issues in current macro-economic models, and is at the centre of many unresolved controversies between different schools of economic thought. The major point needing clarification is the degree to which investment can usefully be regarded as an autonomous variable, in the sense of being independent of the level of income or other variables in a system of income determination. Given this situation it is necessary to investigate the nature and stability of the investment function empirically in order to construct meaningful econometric models capable of being statistically tested, and thus evaluating the current theories.

In the most simple version of the Keynesian model consumption, which is identified with induced expenditures, is given as being a stable function of income, while private investment, along with government expenditures, identified as autonomous expenditures, are the only means available for adjusting national income, which may come into equilibrium above or below the full employment level. In this model the role of 'autonomous' expenditures along with the 'multiplier' is seen as being the only important variable determining the level of national income. If this model was an accurate portrayal of reality then the identification of the investment function would be the central empirical problem of macro-economics. Unfortunately this simplistic model has been shown to be of little value as an explanation of economic activity. In research using United States time series data from 1897 - 1958 Milton Friedman and David Meiselman showed that the simple Keynesian model gave very poor results in comparison with a simple monetary model. [17] The simple model is also extremely unrealistic in that it ignores monetary effects in the system. There are also problems of definition in this model, for example the identification of investment and govern-

ment expenditures with autonomous expenditures is not as clear cut as the model implies. In the case of investment expenditures, these are influenced in turn by the level of income and by monetary conditions, so that it may be only within very close limits that investment can be regarded as autonomous. On the other hand certain elements of consumption expenditure (possibly consumer durables) may be better classified as autonomous expenditures. The influence of this fact on present day economic thought is exemplified by H. G. Johnson's statement,

'For pure theory, the essential Keynesian concept is the functional dependence of aggregate expenditure on itself in its income-generating capacity. The division of expenditure into consumption and investment is superfluous complication once one drops the restrictive assumption that consumption depends only on income and investment only on the rate of interest, and permits both to change autonomously.' [20 p.141]

and also by Friedman who says,

'The crucial distinction in the income-expenditure analysis is not between consumption and investment but between expenditures that are independent of the level of income (or any other variables regarded as endogenous to the system) and expenditures that are linked to the level of income.' [17 p.247]

If it is the case that all categories of expenditure are endogenous to the system, or have only a very small degree of autonomy, then the investment function would be of interest only in its role as a component of expenditure, and how it reacted in comparison to other components of expenditure in response to changes in the money stock or exogenous factors, that is interesting from a distributional rather than

a stabilisation point of view, as Friedman suggests is the case. This is an extreme view however, and most economists would agree that various categories of expenditure can be varied in a discretionary manner.

The position becomes more realistic when the Keynesian model is examined as a determinate system, with income having some influence on the demand for investment goods. J. R. Hicks shows that the Keynesian model can in fact be presented in this manner. [19 1937] In this model investment and savings are a function of the interest rate. Here an exogenous shift in national income will induce the investment and savings schedules to shift. Since it is assumed to be more responsive to changes in income than investment, higher incomes will be associated with lower interest rates and vice versa. Thus the combination of all points of intersection of the investment and savings schedules at various levels of income give a curve that is downward sloping when plotted with interest rates. This curve represents equilibrium in the real part of the system. The general equilibrium position is arrived at when this IS curve intersects the LM curve which represents equilibrium in the money market, that is the LM curve gives the interest rates and income levels at which the demand for money is equal to the supply. The LM curve is seen as being inelastic in an intermediate range, and perfectly elastic at high rates of interest where there are no idle money balances.

In this model a change in autonomous expenditures, that is a shift in the IS curve will be completely effective in changing national income at low interest rates, (i.e. in the liquidity trap region) or in a situation where full employment investment and savings schedules do not intersect at any positive interest rate, which is likely to be the case if the marginal efficiency of investment is

inelastic at low rates of interest. In this case the autonomous expenditure will be financed entirely from idle balances, so that national income will increase by the amount of the initial expenditure times the full amount of the multiplier. In the intermediate region autonomous expenditures will have some effect, but this will be partly offset by reductions in expenditure elsewhere in the system. Finally in the region where interest rates are at a high level, and there are no idle balances, any changes in autonomous expenditures will be offset by reductions elsewhere in the system and will have no stabilising effect. The opposite position holds for monetary policy. When there are no idle balances changes in money supply will be totally ineffective, in the intermediate region partially effective, and totally ineffective at some low interest rate, where all increases will go into idle balances.

The above analysis came about as a reaction to the assumption of the classical economists that savings and investment were identically equal *ex ante* (Say's Law), and that the IS curve was therefore perfectly inelastic. However there is no *a priori* reason why the income elasticity of investment should not in certain situations be greater than the income elasticity of savings, in which case the IS curve would be upward sloping, since an increase in income would then induce an increase in the interest rate by creating an excess demand for investment, and thus discouraging further investment before an equilibrium situation is reached. In a situation of this nature it would be difficult to exercise a significant degree of control over investment expenditures by movement of the IS curve. As J. R. Hicks puts it,

'There may be conditions when expectations are tinder,
when a slight inflationary tendency lights them up

very easily, then the marginal propensity to consume may be large and an increase in income tends to raise the investment rate of interest.' [19 p.145]

Hicks points out that in a situation of this nature only monetary policy will have any capacity to control the situation.

The problem theoretically is not so much whether autonomous expenditures influence income (given that income is made up of consumption and 'autonomous' expenditures, autonomous expenditures must by definition influence income, provided they are not offset by changes in consumption), but to what degree expenditures commonly given as being autonomous are in fact autonomous. The answer to this question can only be found empirically by isolating the determinants of the various components of national income and determining to what degree these are free to vary independently of the level of income.

For the case of private investment in plant and equipment, a large component of 'autonomous' expenditures it will be necessary to test existing theories for the New Zealand case, and the results should have some significance for the broader questions of macro-economic theory.

If a stable investment function can be derived showing significantly the responses of investment to changes in the system, then some of the theoretical problems can be resolved, at least for the situation to which the function is applicable, in this case the New Zealand economy.

So far research done (mostly for the United States) has indicated that investment is an endogenous variable, being a function of output and the capital stock and various financial variables. Studies showing the role of profits in investment behaviour, which would indicate that investment decisions are autonomous to a greater degree, have not achieved very good results. However apart from the fact that these

issues are far from finalised, these results need not apply in the New Zealand case. Because of New Zealand's less developed capital markets and the smaller scale of New Zealand business it may well be that the results would be reversed in this case. However the danger of extrapolating overseas results to the New Zealand case should not be over emphasised. Economics is a social science dealing with human behaviour, and it is reasonable to expect that human reactions will be similar in New Zealand, Australia and Canada, although different degrees of institutional efficiency may mean that reactions will proceed at different speeds.

3. THE NEO-CLASSICAL THEORY OF INVESTMENT BEHAVIOUR

The neo-classical theory of investment behaviour originates with the work of Irving Fisher. [16 1930] Fisher's theory of optimal capital accumulation assumed that a firm will attempt to maximise its present value, that is maximise the difference between discounted future revenue and discounted future outlays. If it is assumed that there are perfect capital markets then the firm will maximise its present value if it invests in all projects whose present value is positive at the market rate of interest.

However in reality the problem is rather more complex than this, since market rates of interest are not stable and are difficult to predict, making it impossible to predict accurately the returns to an investment. The optimal solutions in times of uncertainty are complicated by the fact that capital markets, in reality, are generally imperfect, with the borrowing rate differing from the lending rate so that capital when put in place will not readily be disposed of in response to changes in prices.

However if the above difficulties are assumed away then the problem becomes rather more simple and investment will take place, as described by Keynes, to the point where the marginal efficiency of capital is equal to the marginal cost of funds, which Keynes represents by a market rate of interest, and the supply is assumed to be perfectly elastic at the going price. Keynes defines the marginal efficiency of capital (M.E.C.) as 'being equal to that rate of discount which would make the present value of the series of annuities given by the returns expected from the capital-asset during its life just equal to its supply price.' [29 p.136] The concept of the M.E.C. also encompasses the problem of uncertainty to some degree, since Keynes makes it clear that

it is determined by expectations of yield as well as by real factors.

By aggregating the M.E.C. of all investment projects in an economy an investment demand schedule can be derived. Keynes says,

'If there is an increased investment in any given type of capital during any period of time, the marginal efficiency of that type of capital will diminish as the investment in it is increased, partly because the prospective yield will fall as the supply of that type of capital increased, and partly because, as a rule, pressure on the facilities for producing that type of capital will cause its supply price to increase.' [29 p.136]

The investment demand schedule relates the level of investment to its marginal efficiency. If the M.E.C. is replaced by a corresponding interest rate we get a declining demand for investment as interest rates rise. The actual marginal efficiency of investment (M.E.I.) will be determined by a number of factors. M. K. Evans [13 p.79] lists four primary influences, which are :-

1. The level of demand - an expected increase in future returns will tend to push out the marginal efficiency of investment schedule.
2. An increase in the capital stock - this will tend to lower the returns to each additional investment, and so will be in a negative relationship with the marginal efficiency of investment.
3. The relative age of capital stock - in particular in an industry with rapid technological development. Evans says, 'In such cases firms may invest capacity or do not expect future increases in demand.'
4. The degree of uncertainty surrounding the anticipated

returns of a firm, where he says, 'Partially because of this asymmetry in buying and selling prices, variability of expected future returns will lower the M.E.I. schedule.'

Keynes lays particular stress on the importance of the M.E.I. in as far as it reflects expectations about the future. He says, 'The schedule of the marginal efficiency of capital is of fundamental importance because it is mainly through this factor (much more than through the rate of interest) that the expectation of the future influences the present.'

[29 p.145]

and he notes that it provides an essential theoretical link between the present and the future.

The theory of investment put forward by Keynes is, however, incomplete in that it fails to take into consideration the fact that the supply of funds to investors is not perfectly elastic (as is implied by using a single market rate of interest to represent the cost of funds, but tends to increase with financial risk.

The cost of funds side of investment analysis is treated more thoroughly by J. S. Duesenberry [8 pp. 93-96], whose conclusion is that,

'the supply schedule of investible funds will vary in level and shape with the debt position of firms. For public utilities it will start at a fairly high level, but have only a moderate slope. For many but not all manufacturing companies the short-run supply schedule will have an elastic range and then a steeply rising range. The width of the elastic range in terms of investment will depend on the amount of retained earnings and depreciation

expense.

There is general agreement among investment theorists that the marginal cost of funds schedule does rise as the firm increases its level of debt, thus increasing financial risk. However there is some disagreement as to the exact form of the marginal cost of funds curve. Theorists who attribute changes in the level of investment primarily to internal funds tend to adopt the view that the curve has an elastic range, and then becomes highly inelastic when internal funds are exhausted, while those who see internal funds as being of relatively minor importance see the marginal cost of funds curve as rising more gradually. Whatever the exact form of the marginal cost of funds curve it is evident that cost factors cannot be ignored in a well specified model, and that the desired level of investment is determined by the intersection of the M.E.I. schedule with the marginal cost of funds schedule.

In summary then, investment will depend on changes in output, size of capital stock, the debt position of the firm, interest rates, taxation systems, and other cost factors, and on expectations in as far as these are not accounted for by the above variables.

From the above discussion of the elements of the neo-classical theory it is evident that an econometric representation of this theory could be approached in a number of ways, depending on how the cost of funds is represented, and on the constraints one puts on the model in the form of assumptions about the optimal mix of inputs required to maximise utility and the degree to which these inputs are substitutable, that is the type of production function adopted. However for purposes of econometric verification the neo-classical theory can be broadly defined, as it is done by D. W. Jorgenson, one of its foremost proponents. in the following way:-

'Reduced to its barest essentials, the theory requires only that capital accumulation be based on the objective of maximising the utility of a stream of consumption. This basic assumption may be combined with any number of technological possibilities for production and economic possibilities for transformation of the results of production into a stream of consumption.' [24 p.135]

4. THE ACCELERATOR PRINCIPLE

The two most important variables affecting the demand for capital investment appear to be output, or sales, in as far as they give an indication of future demand, and the existing capital stock or capacity of the firm. These are the variables on which the accelerator principle is based. The accelerator principle was demonstrated by J. M. Clarke [6 1917], using fluctuations in railroad traffic and purchases of railroad cars to show the effect of the above factors. Clark concluded that the capital stock moved in proportion to demand, and that if demand were to remain constant then net investment would eventually become zero.

This effect of output on investment is central to dynamic Keynesian theory [e.g. 18] which explains movements in aggregate economic activity (at the most general level) by the effect of investment on income through the multiplier, then through the feedback effect of output on investment through the accelerator. At this level however the determination of investment expenditures is grossly oversimplified. Clark noted that output and capital stock did not provide a sufficient explanation of investment. He pointed out that the effects of changes in output and the capital stock would be modified by the degree of capacity utilisation, and that there were lags between output changes and investment expenditures.

The performance of the simple accelerator has been shown to be poor by comparison with more sophisticated models. However it has provided a useful theoretical principle, and has provided the basis for most subsequent work on aggregate investment behaviour.

The simple accelerator was modified by H. B. Chenery [5 1952] in an attempt to incorporate a measure of capacity utilisation in the model. Although the performance of this model was superior to the

simple accelerator, it was still inadequate in that it did not allow for the full effect of lagged reactions.

A more sophisticated version of the accelerator principle was put forward by L. M. Koyck in his book 'Distributed Lags and Investment Analysis' [30 1954]. Koyck pointed out that there are technological and institutional factors which may prevent businessmen from reacting [30 p.6] immediately to changes in demand. Also in making an investment in new plant and equipment there is a certain amount of risk since the businessman may not be able to judge whether changes in demand will be permanent or are merely the result of transitory factors. The effect of these factors is to inhibit investors so that responses to changes in demand will not be immediate, and there will be a significant lag before their full reaction can be observed. Koyck says,

'... it may be quite insufficient to speak of the elasticity of an economic reaction; in many cases it will be necessary to specify the period of time to which the elasticity applies.' [30 p.16]-

There are a number of possible structures which this lag could take; Koyck however uses a series of geometrically declining weights, which go back to a time period which has an insignificant influence on current behaviour.

5. THE EFFECT OF CAPACITY UTILISATION AND THE COST OF FUNDS ON THE ACCELERATOR MECHANISM

The neo-classical theory of optimal capital accumulation and the flexible accelerator have formed the basis of most subsequent attempts to explain investment behaviour. However there is still considerable disagreement among econometricians as to how these two elements should be incorporated in a practical model. It is generally agreed that the flexible accelerator alone does not provide a complete explanation, since it ignores factors affecting the cost and availability of capital, which should, theoretically, have a significant influence on the demand for capital services. Although it is agreed that changes in output alone are not sufficient explanation, there is some disagreement as to what other factors significantly affect the demand for capital services, and also as to how these factors should be entered in a regression model.

An important consideration affecting the accelerator mechanism is the degree of excess capacity in the economy. In a situation where there is under utilisation of the existing capital stock, an increase in demand will tend to be reflected in increased utilisation of the existing stock rather than by increased investment, so that only when the economy is operating at full capacity will the accelerator come into full operation. Capacity utilisation can however be incorporated in a model in several ways. The position regarding excess capacity is summed up by Meyer & Kuh -

'The most common solution has been to view excess capacity primarily as a cyclical phenomenon, so the accelerator works in an upswing but becomes inoperative during a downswing. Others, while recognising cyclical over-

capacity, go further and suggest that secular excess capacity is often needed for profit maximisation in an industry with increasing returns to scale and growing output. Given secular overcapacity, the level of output and the firm's capital stock become the relevant variables rather than change in output alone.' [38 p.15]

Alice Bourneuf points out however that the relationship is not a simple one,

'An analysis of the effect of output on investment must consider not only the direct effect of output changes on investment but also the indirect effect of output changes on excess capacity and through excess capacity, on investment. Furthermore, investment as affected by output changes, then increases capacity, excess capacity and replacement needs, and therefore, in turn, affects investment in future years. To analyse the full influence of output changes on investment over time an equation is needed to estimate the effects of investment on total capacity or on changes in capacity. A complete explanation of capacity would require many variables.' [4 p.612]

The theoretical problems regarding the effect of capacity utilisation have largely been resolved. However problems still arise from the use of different definitions of capacity [31] and in statistically specifying a capacity variable. The above analysis points out the need to include a measure of capacity utilisation in an investment model. However because of the theoretical complexity of the problem it may be that a simple measure of capacity would not provide significant results. If this is so it should be sufficient

to use the rough approximation mentioned by Meyer & Kuh (above), of a relationship including output and capital stock, provided that this produces statistically significant and theoretically plausible results.

While the principles regarding the inclusion of output and capacity variables in a model has been largely agreed upon, the position as to the cost of funds and the effect of the availability of various types of finance is subject to considerable controversy. The neo-classical theory suggests that the desired level of capital stock is determined by the intersection of the marginal efficiency of investment (MEI) and the marginal cost of funds (MCF) schedules, at which point the cost of a project is just compensated for by its return.

J. S. Duesenberry maintains that different regions of the MCF schedule are characterised by the use of different types of funds, with the cost of funds rising according to the type used. [8 pp.93-96]

Retained earnings are seen as being the cheapest, having an opportunity cost equal to the market rate of interest, debt finance is seen as being more expensive because of the necessity of paying higher risk premiums as the amount of debt rises, and equity finance is seen as being the most expensive, because new stock issues depress the price and hence raise the yield that is paid. If this theory were accurate it would be expected that each of these types of finance would show up as being significant in a regression model. This does not however appear to have been the case, as tests of Duesenberry's theory by Resek[‡] and by Anderson have failed to produce satisfactory results. This suggests that the source of funds used does not affect the cost of an investment, and that the type of finance used is determined by considerations other than direct cost.

The role of profits in determining the desired capital stock

‡ See following section.

has been given considerable attention by investment theorists.

Tinbergen argues [42] that the objective of the firm is to maximise its profits, and that past profits can be used to predict future profits. He does however add a caution to this conclusion,

'One has of course to be careful with the interpretation of the correlation between profits and investment, which could as well be such that investment determines profits, instead of the other way round. Then the mere fact that their mutual correlation is better than the one required by the acceleration principle would not prove much. There are however reasons for believing in the interpretation given, and then it seems that a better explanation of investment is possible than the poor one yielded by the acceleration principle.' [42 p.176]

It must be noted here that Tinbergen compared his 'profit principle' with the simple accelerator, using simple correlation techniques which have since been superseded by multiple regression analysis. It would be unreasonable therefore to put much weight on Tinbergen's findings in light of more recent research, which gives little support for the profits theory. Profits tend to fluctuate considerably from one time period to another, making it extremely difficult to predict future profit levels from past profits. It is necessary therefore to take other factors into consideration in assessing the value of a firm. An alternative rationalisation for the profits theory is that the level of profits constrains investment expenditures. However in a modern economy with well developed capital markets, the level of profits should not be an unduly restrictive constraint on a

a well managed firm, since lenders of funds will not be unduly influenced by fluctuations in profits, and will take account of other factors such as sales level and market share trends.

In general empirical tests have shown that profits do not provide a highly significant explanation of investment. In comparison with other models internal fund models have been shown to perform rather poorly. Charles Bischoff tested five different types of models using common data, and found that the predictive power of cash-flow models was inferior to output based models, and that the power that cash flow models did have could be attributed to the correlation between profits and output, which was however broken over the prediction period (1970-71).

[3]

Jorgenson, Hunter and Nadiri [27] reached a similar conclusion in a comparison of the predictive powers of four models, finding that the Meyer and Glauber model, [7] which attributes changes in investment primarily to profits, was inferior to the neo-classical model of Jorgenson and Stephenson [28] and the conventional flexible accelerator model of Robert Eisner [9] and to the Anderson model [2].

These results with respect to profits are puzzling in light of popular economic theory which has long accepted the doctrine of profit maximising behaviour on the part of business firms, and the contingent assumption that investment would be stimulated by profit making projects. It has been accepted that through maximising profits the value of the firm is maximised, this being the optimal position for shareholders. An explanation for this paradox has been suggested by Modigliani and Miller who show that although profit maximisation and maximisation of the value of a firm are equivalent under conditions of certainty, they cease to be equivalent in a situation such as

prevails in the real world. This is explained as follows :-

'... with the recognition of uncertainty this equivalence vanishes. In fact, the profit maximisation criterion is no longer even well defined. Under uncertainty there corresponds to each decision of the firm not a unique profit outcome, but a plurality of mutually exclusive outcomes which can at best be described by a subjective probability distribution. The profit outcome in short, has become a random variable, and as such its maximisation no longer has an operational meaning. Nor can this difficulty be disposed of by using the mathematical expectation of profits as the variable to be maximised. For decisions which affect the expected value will also tend to affect the dispersion and other characteristics of the distribution of outcomes. In particular the use of debt rather than equity funds to finance a given venture may well increase the expected return to the owners, but only at the cost of increased dispersion of the outcomes.' [39 p.263]

In view of these facts, and the subjective nature of the choice to be made between these possible outcomes Modigliani and Miller conclude that the objective of management will be to maximise the value of the firm, and in order to do this they will undertake any project which increases the market value of the firm's stock. This explanation is consistent with findings that have shown output and capacity variables to be the dominant determinants of investment behaviour, this allows for firms to use long term market share and other criteria in attempts to increase the value of their stock.

However it should not be implied from the empirical results that profits are unimportant. While output models are apparently preferable to profit models this does not detract from the importance of profits. No firm can survive in the long run without making profits, so that in this sense profits have a determining influence on all the firm's activities. However profits cannot be used to directly predict all aspects of a firm's behaviour, and evidence suggests that investment behaviour can be explained more successfully by other considerations.

In addition it must be remembered that these results apply to the American situation, and it may be the case that in New Zealand the marginal cost of funds schedule may be inelastic when internal funds are exhausted; if this is the case, then profits may have a more significant effect in the New Zealand situation.

The results associated with external finance are also confusing. The implication of Duesenberry's theory is that if two identical firms, with their MEI and MCF schedules intersecting at the same position, then behaving rationally they will use similar financing methods in response to an increase in the desired capital stock, that is they would use debt finance at one point, equities at another, and that if one firm used the more expensive finance then the value of that firm would drop accordingly. However Modigliani and Miller maintain that the cost of debt and equity finance to a firm when differential tax treatment is taken into consideration, is equal, [37] so that the value of a firm is independent of its financial structure. For example if a firm uses debt finance it increases the risk assumed by holders of its ordinary shares, so that it will be forced to pay a higher yield on its shares. If it does not pay the higher yield holders

of its stock will benefit by selling their shares in this company and buying the lower risk stock in the equity financed company, that depressing the value of the stock in the first company and increasing its yield. In this manner any difference in the value of two firms induced by financial structure will be eliminated by arbitrage.

In empirical studies external finance has been represented by interest rates, rates of return, stock prices, and the market value of the firm. In general variables associated with external finance play a more important role than variables representing internal finance, in particular Resek found that interest rates are significant, and an index of stock prices to be highly significant. [40] However external finance variables have been shown to be much less important than variables associated with output. In general these findings corroborate the findings of Modigliani and Miller who show that the cost of finance to a business is independent of its source and investment behaviour is not highly correlated with changes in the use of particular categories of funds.

6. REPLACEMENT INVESTMENT

The choice of a model of replacement is important since replacement makes up a large proportion of investment at the aggregate level. The geometric mortality distribution is a popular assumption adopted in empirical work. For this distribution replacement is proportional to actual capital stock. Jorgenson justifies this assumption as follows :-

'... the appropriate model for replacement is not the distribution of replacements for a single investment over time, but rather the infinite stream of replacements generated by a single investment; in the language of probability theory, replacement is a recurrent event. It is a fundamental result of renewal theory that replacements for such an infinite stream approach a constant proportion of capital stock for (almost) any distribution of replacements for a single investment and any initial age distribution of capital stock. This is true for both constant and growing capital stocks.' [23 p.251]

Robert Eisner disagrees with Jorgenson's argument maintaining that

'If the probability of exhaustion of capital stock is very small in the early period of its life one should hardly expect replacement requirements to continue at a constant ratio of capital after a burst of investment which substantially alters the age distribution. Depreciation should approximate a constant proportion of some long run or 'permanent' value of capital stock. It will be a smaller proportion of a temporarily

younger capital stock resulting from higher than usual net investment and will be a higher proportion of a temporarily older capital stock resulting from less than normal net investment.' [12]

While Eisner's argument may well be true for the case of investment in a single firm or industry, it can be safely assumed that these cycles would be damped in a highly aggregated model such as is necessary for plant and equipment for the New Zealand economy. While past investment policies, or the state of overseas reserves may well cause waves in replacement investment at low levels of aggregation, the different life spans of plant and equipment in the various sectors and various industries should eliminate this problem at the aggregate level, and it seems reasonable to assume that replacement would be approximately proportional to the existing capital stock.

7. LAG STRUCTURES

The preceding analysis gives some indication of the motivations for investment behaviour. It cannot however give an indication of the rate at which investment will take place. Additional information is needed to determine the rate of investment per unit time. There are a number of factors which prevent changes in desired capital stock from being reflected immediately in changes in the level of investment. Before investment can respond to changes in the determining variables there are a number of inhibiting factors which cause the reaction to be lagged over a number of periods. Firstly there is the lag between the recognition of the need for a new level of capital stock and the actual ordering of equipment, then there is the lag between the ordering of equipment and its delivery. It may also be that businessmen do not react immediately to changes in sales and other variables because they do not immediately recognise the new level as being 'permanent' as is suggested by Robert Eisner [10].

In an ideal situation a rational lag structure could be incorporated into the ordinary least squares equation for investment behaviour, with each lagged term entering the equation as a separate variable. In practise however this procedure often gives rise to statistical difficulties because of the fact that lagged values are often highly intercorrelated. This results in high standard errors of the estimated coefficients. It has been necessary therefore for investment theorists to constrain their lag structures in some way in order to reduce the number of coefficients which must be directly estimated.

A lag structure for investment behaviour was first incorporated in a model by L. M. Koyck [30]. Koyck noted that the previous

year's output often influenced investment more than the current year's output, and he posulated that thereafter the influence of preceding years could be described by a declining geometric progression back to a year in which output had a negligible influence on current investment. This relationship was expressed as follows :³

$$K_t = \alpha O_t + \delta \sum_{i=0}^{\infty} \lambda^i O_{t-i-1} \quad \text{with}$$

where capital stock K is related to output in a number of preceding periods.

Koyck's theory of a long distributed lag was tested by Eisner. Eisner did not use a lag structure however but estimated each term separately giving the general form

$$I = a_0 + a_1 \Delta S + a_2 \Delta S_{t-1} + \dots + a_7 \Delta S_{t-6}$$

where I = investment, S = sales, Δ = change.

Although this model confirmed Koyck's model the test must be regarded as unsatisfactory because of the high probability of there being multicollinearity among the sales terms.

Since Koyck's study there have been a number of alternative suggestions put forward for characterising the lag structure of the investment process. The most flexible technique has been developed by G. Almon.^[1] Almon postulates that the lag can be approximated by a continuous function. Various lag lengths are tested in order to determine which will give the best fit with the data. The use of this technique for investment models has generally indicated that the lag weights form an inverted V pattern ^[13 p.109] which suggests that the Koyck procedure is not an appropriate method for obtaining the best lag weights in an investment model.

It is impossible to decide which type of lag structure provides the most realistic representation of the investment process without some recourse to independent estimates of the lag structure.

This has been attempted by D. W. Jorgenson [22]. Jorgenson compares the lag structures used by various researchers with survey studies of lags between decisions to invest and the start of construction and between the start of construction and completion made by Thomas Mayer [35, 36].

Mayer obtained average lags from the drawing of plans to the start of construction of six months, and from the placing of the first significant order to start of construction of two months, and from start of construction to completion of fifteen months [35]. From these results Jorgenson is able to conclude whether lag structures are realistic. In a survey of the large number of models Jorgenson found that geometric distributed lags 'conflicted sharply with Mayer's survey evidence' [22 p.1136]. He implied from this that geometric distributed lags are misspecified and that tended to bias the estimated average lag upward very substantially.

Jorgenson finds that the most realistic lag is that used by Jorgenson and Stephenson [28] and has the form

$$K_t = \sum_{r=2}^r \gamma_r K_{t-r} - W_1 \Delta K_{t-1} - W_2 \Delta K_{t-2}$$

where

$$\sum_{r=2}^r \gamma_r = 1 + W_1 + W_2$$

1.5 or 2.68 years average.

In studies with a satisfactory lag structure it was found that the typical shape of the lag distribution was first rising then falling.

Unfortunately there is no data available comparable to Mayer's surveys available for New Zealand. Since we have no a priori information on the length or form of lags it is necessary to use a procedure of finding weights giving the best statistical fit. While

this procedure is not ideal it has provided satisfactory results in models of the Australian and Canadian economies [15][34] and should work in the New Zealand situation. Because of the different scale and structure of the New Zealand economy it would not be reasonable to use American survey results to evaluate lags calculated for the New Zealand economy. It is difficult to say without further information whether lags in the New Zealand situation would be longer or shorter than those in the United States. Because of the fact that a significant proportion of New Zealand's capital equipment is imported there could be a tendency for lags to be longer because of additional ordering problems and the possibility of shipping delays. On the other hand the smaller scale of New Zealand business may facilitate quicker decision making, which would shorten the lag. The feasible length of lags to be tested is also constrained by the relatively small data samples available. Because reliable quarterly data is only available from 1960 it would be difficult to test lags much longer than about ten quarters. However this should be adequate since the available evidence on overseas experience suggests that lags generally peak at between four and six quarters, from which points weights taper rapidly to zero at from seven to twelve quarters [13 p.204]. Little explanatory power would be gained therefore by extending lags beyond this length, while the loss of degrees of freedom through the decreased sample size would significantly affect the precision of the estimated coefficients.

8. A SURVEY OF ECONOMETRIC MODELS

There is general agreement in the econometric literature that output models are superior to cash-flow models. However there are still considerable differences of opinion as to what type of output model provides the most satisfactory representation of the neo-classical theory of optimal capital accumulation.

Firstly there are the more conventional flexible accelerator thereists represented by R. Eisner, A Bourneuf, R. W. Resek and others. The accelerator models have been specified in a number of different ways. Resek and Bourneuf [40][4] let each determinant enter the regression as a single variable.

Reseks model [38 p.329]

$$\begin{aligned} \frac{I}{K} &= a_1 + a_2 Q_2 + a_3 Q_3 + a_3 Q_4 \\ &+ b_1 \left(\frac{O}{K} \right)_L + b_3 \tau_L \\ &+ b_4 \left[\frac{1}{M - \frac{D-F}{A}} \right]_L + b_5 SP_L \end{aligned}$$

This model is a representation of Duesenberry's theory of investment [40 p.323] and investment (I) is related to output (O), change in output, (O) [these two could not be included in the one equation because of multicollinearity, but were treated as substitutes for one another], the interest rate (τ) and debt capacity

$$\left[\frac{1}{M - \frac{D-F}{A}} \right]$$

and an index of stock prices SP, with D = Debt, F = retained earnings, A = Assets and M a constant larger than D/A.

The Almon technique is used to determine a fixed lag distribution for all variables. Resek finds that the interest rate and stock prices are generally significant and that change in output and output are reasonably significant. His results are generally

unsatisfactory however. In a survey of a number of industries the R^2 for the above equation ranges from .567 for food to .897 for non-electrical machinery and electrical machinery, and the D.W. statistic ranges from .40 for non ferrous metals to 1.37 for non-electrical machinery [40 p.333].

Eisner's model [10][11]

An alternative specification of the flexible accelerator model is used by R. Eisner, who allows some determinants to enter the regression function as a number of separate variables representing different lagged values of the same variable, to give the following general form :-

$$i_t = b_{10} + \sum_{j=1}^7 b_{1j} S_{t-1-j} + b_{18} P_{t-1} + b_{19} \overset{D}{D}_{53} + U_t \quad [11 \text{ p.239}]$$

where i_t = a measure of the relative change in the capital stock

S_t = a measure of the relative change in demand

P_{t-1} = a measure of the profit irate

D_{53} = a measure of durability of capital and replacement requirements

U = a disturbance term. ^{*}

The time structure used is a version of Koyck's distributed lag function with weights determined arbitrarily for first lagged values of profits and sales, then declining geometrically. Eisner finds that changes in sales are highly significant while for profits only one of the coefficients for changes in profits exceeds its standard error. The model used by Eisner can be regarded as being outmoded since the perfection of more sophisticated techniques of estimating lag structures. It is also possible that the high standard errors of the profit

* In different studies Eisner tests a variety of hypotheses within the general framework illustrated above. [9][10][11]

coefficient could be the result of multicollinearity rather than the result of faulty theoretical specification. Multicollinearity would render the estimated coefficients extremely unreliable.

Neither Resek's nor Eisner's model takes into consideration the price of capital relative to the price of output in determining the optimal capital stock, they therefore implicitly assume that it is not possible to substitute for capital, that is they adopt a production function in which the elasticity of substitution of labour for capital is zero.

Dale Jorgenson sees this as being a mis-specification of the neo-classical theory (as outlined in Section 3) and he includes the implicit rental price of capital in his model, assuming the elasticity of substitution of capital for labour to equal one. Jorgenson maintains that the firm will operate so as to maximise its present value, which is equivalent to maximising the difference between discounted future revenue and discounted future outlays - thus the cost of capital and therefore the tax structure, is of considerable importance. There are however two constraints operating on this objective - a production function having an elasticity of substitution for labour and capital input equal to one, and secondly assuming that net investment is equal to total investment minus replacement, where replacement is proportional to the capital stock. Jorgenson expresses these conditions in the form of a lagrangian function which is differentiated with respect to capital and labour inputs to obtain the marginal cost of the inputs. The differentials are then equated to the marginal productivity of the inputs as derived from the production function to give the optimal level for each input. Jorgenson assumes that the actual capital stock approaches this optimal level through a rational distributed lag structure.

Jorgenson and Stephenson estimate the following model

for total manufacturing :-

$$\begin{aligned}
 I_t = & (.00305) \left[\frac{P_{t-4} Q_{t-4}}{C_{t-4}} - \frac{P_{t-5} Q_{t-5}}{C_{t-5}} \right] \\
 & + (.00153) \left[\frac{P_{t-5} Q_{t-5}}{C_{t-5}} - \frac{P_{t-6} Q_{t-6}}{C_{t-6}} \right] \\
 & + (.00190) \left[\frac{P_{t-6} Q_{t-6}}{C_{t-6}} - \frac{P_{t-7} Q_{t-7}}{C_{t-7}} \right] + (.00270) \left[\frac{P_{t-7} Q_{t-7}}{C_{t-7}} - \frac{P_{t-8} Q_{t-8}}{C_{t-8}} \right] \\
 & + 1.20525 [I_{t-1} - K_{t-1}] - .36316 [I_{t-2} - K_{t-2}] \\
 & + .02084 K_t \quad R^2 = .96440 \quad D.W. = 1.9597
 \end{aligned}$$

[28 p.189 & 190]

Where I_t is a measure of gross investment

Q = real gross value added

P = a price index for Q

C = the implicit rental cost of investment goods

K_t = a measure of the capital stock

= the assumed rate of depreciation.

Charles Bischoff suggests that Jorgenson's model is unsatisfactory. Bischoff found that a generalised accelerator model (similar to that used by Koyck and Eisner) performed better than a version of Jorgenson's standard neo-classical (S.N.C.) model. He concluded that this was due to the fact that the S.N.C. model was mis-specified in that by assuming a Cobb-Douglas production function, implying unitary elasticity of output with respect to relative prices ($Y = AKL^{1-}$) it does not distinguish between the explosive response of investment to changes in output from the more gradual response to changes in the cost of capital, Jorgenson's model assumes perfect capital markets which is unrealistic, because most physical capital is of a specialised nature and becomes semi-permanent once put in place, so that an increase in

the relative cost of capital would result in a less than proportionate decrease in the capital stock.

A similar criticism of the neo-classical model of Jorgenson is put forward by Robert Eisner who maintains that

'... Jorgenson's conclusions are not sustained by his data. Rather it appears that they follow from

crucial a priori constraints upon parameters.' [12 1968]

namely that the elasticity of desired capital stock with respect to both output and relative prices is unity when in fact the evidence is against this assumption -

'Unitary elasticity with respect to relative prices

would contradict the growing if still uncertain

evidence from estimates of constant elasticity of

substitution (C.E.S.) production functions that the

elasticity of substitution is less than unity.' [11 1968]

In a function in which the assumption of unitary elasticity of output with respect to relative prices is dropped Eisner estimates a barely significant elasticity of .1576, similar tests with respect to output were considerably higher (.8158), from this Eisner concludes that Jorgenson's data permits the operation of 'a potent accelerator' and that,

'All in all there appears to be scant empirical support

for the usefulness of the 'Neo-classical' model of

capital accumulation.' [12 p.375]

Eisner also points out the possibility of there being different lag structures for the response of investment to changes in relative prices and for changes in output, and suggests that the response of net investment to changes in relative prices would be markedly slower than the response to changes in output.

These two modifications suggested by Eisner and Nadiri are adopted by MacKinnell, Frisch and Roope₂ (M F & R) in their investment model of the Australian economy. M F & R replace Jorgenson's expression for the optimal level of capital,

$$1. \quad K^{\#} = a \frac{P}{c} Y$$

with the more general expression

$$2. \quad K^{\#} = a \left[\frac{P}{c} \right]^{E_P} Y$$

where E_P is the elasticity of desired capital stock with respect to relative prices. From this they derive an alternative model to Jorgenson's -

$$3. \quad I_t = gK_{t-1} + \sum_{i=0}^n w_i \left[a \left(\frac{P}{c} \right)^{E_P} Y \right]_{t-i}$$

M F & R substitute a range of values from one to zero into the above equation for E_P and find that the most precise estimate (that having the lowest standard error) is obtained by using a value of 0.32 (this value is somewhat higher than the value suggested by Eisner, and still allows the Jorgenson theory to provide the basic framework for a model, whereas Eisner figure of .1576 tended to suggest that Jorgenson's theory could be abandoned and replaced by a conventional flexible accelerator model).

To test Jorgenson's assumption of identical lag distributions between investment and changes in output and relative prices, M F & R calculate coefficients for the following equation

$$4. \quad I_t = gK_{t-1} + \sum_{i=0}^{m1} f_i \left(\frac{P}{c} \right)^{E_P} Y_{t-i} + \sum_{i=0}^{m2} j_i Y_{t-i}$$

Jorgenson's assumption is tested by substituting different lag structures into the above equation (using the Almon technique), assuming that the lag yielding the lowest standard error for each of the

coefficients f and j, is the appropriate one. The above equation yields the best lags for output and relative prices of 14 and 16 quarters respectively. The standard errors obtained for equation four are however higher than those for equation three, so M F & R use equation three which gives the following result:-

$$5. \quad ie_t = 149 - 96 S_1 - 32 S_3 + .0328 Ke_{t-1} \\ \quad \quad \quad (10) \quad (11) \quad (.0027) \\ + \sum_{i=4}^{15} W_i \left[\left(\frac{Pg}{ce} \right)^{.32} gnp \right]_{t-i} \\ R^2 = .952 \quad S.E.E. = 17.308 \quad D.W. = 2.54$$

where ie = equipment investment (deflated)

ke = equipment capital; the depreciated

capital stock for equipment investment.

Pg = The implicit deflator for GNP at market prices

ce = The implicit rental price of capital

gnp = Gross National Product at market prices.

This model appears to provide a satisfactory representation of equipment investment in the Australian economy, which in many respects is similar to the New Zealand economy. It may be therefore that this model would be appropriate to the New Zealand situation.

An alternative version of the neo-classical model, incorporating the role of relative prices has been suggested by Charles Bischoff in the Federal Reserve - M.I.T. - Pennsylvania, (F.M.P.) model. This model treats equipment asymmetrically. Instead of adjusting towards a desired stock of equipment, firms are assumed to move towards a desired level of productive capacity, and they respond to change in output prices relative to the rental price of capital by changing the capital intensity not of the entire stock, but only of new net or replacement capacity put into place.

Bischoff's model is specified as follows :-

$$\begin{aligned}
 I_t &= b_0 + \sum_{i=1}^n b_{1,i} \left(\frac{P}{C}\right)_{t-i-1}^{39} Q_{t-i} \\
 &+ \sum_{i=1}^n b_{2,i} \left(\frac{P}{C}\right)_{t-i-1} Q_{t-i-1} \\
 &+ b_{n+1} K_{t-1} + U_t \quad [3 \text{ p.17}]
 \end{aligned}$$

where Q = gross value added of private business sector

P = price index

C = implicit rental cost of capital

K = capital stock.

Of five models tested by Bischoff - including a 'standard neo-classical' model, a flexible accelerator model, and two cash-flow models, the FMP model shown above performed the best. Tests gave evidence of a high degree of serial correlation in all models except the FMP model. In all statistical respects the FMP model appeared to be the most sound - it had the highest coefficient of determination (R^2), lower standard errors for the coefficients, and a good Durbin-Watson statistic (D.W.).

When the models were extrapolated to 1969 and 1970 the best performer was the FMP model, followed by the generalised accelerator. The two cash-flow models were the least successful. Bischoff says 'this was unexpected because these two equations provided the second best explanation in the sample period both for equipment and structures - this is because the share of corporate profits in output has been unusually low recently.' [3 p.33] He points out that in trying to distinguish between output based and profit based theories researchers in the past have been plagued by the very close relationship between profits and sales. However the profit share was exceptionally low in 1967-70. These years therefore provided a situation in which the correlation was broken, and the results did

not favour the profit based models.

A similar state of affairs has occurred in New Zealand. Cost push inflation has squeezed profits in a similar manner, so that profits have fallen, while output has increased (although at a declining rate). However if this situation continues for any length of time capital equipment may not be replaced, so that in the long run output will fall in line with profits. So while output models may be superior under present conditions, this may prove to be a temporary phenomenon.

An interesting feature of all the models tested by Bischoff was that none performed in a satisfactory manner when 'ordinary-least-squares' (O.L.S.) was used, so that all models were transformed for first order serial correlation. In this case it may have been preferable to have included additional variables in the equations in an attempt to find an economic explanation for the serial correlation, rather than to transform the models for serial correlation as was done by Bischoff. For instance none of the models tested included an index of capacity utilisation; the inclusion of this variable may well have removed some of the serial correlation. Thus while Bischoff's study is useful for comparative purposes, the models are incomplete for practical purposes, since the fact that the serial correlation is not given an economic interpretation means that there is a danger of the models predictive powers failing if the serial correlation does not continue in the expected first order form.

Survey Conclusions

The model used by Mackrell, Frisch and Roope incorporates the characteristics which have proved most successful in models overseas. Firstly it is based on a derivation of the neo-classical theory which has proved to be basically sound in a number of situations. [28] [3] [34] It also includes a specification of the implicit rental cost of capital which has provided significant results, and which in principle can be used to examine the effects of monetary and fiscal policies which must be one of the main objectives of an econometric model of this nature. It can also be conveniently modified to allow for different elasticities of the desired capital stock with respect to relative prices. And finally it is constructed of variables for which data is readily available from the Reserve Bank of New Zealand Database.

There are however a number of potential weaknesses in the study. The practise of using the lag structure giving the best statistical fit was used, which is not an entirely satisfactory technique, so results cannot be regarded as conclusive. In the case of the M, F & R model a decision is made on the basis of the coefficient of determination R^2 , standard error S.E.E., coefficient of variation C.V. and the Durbin-Watson statistic D.W. [34 p.13], the lag structure chosen as being the best is the preferable one in terms of the above properties, however it is not the best in all respects, and cannot be said to have significantly better properties than some of the other lag structures tested. The final choice was therefore, to a large extent subjective. The lag structure chosen is theoretically rather implausible in that the coefficients of desired capital stock are constrained to be zero in the three periods preceding investment expenditures, and in the current period, implying that investors respond only to stimuli received a year or more before actual expenditures are made, where in fact it would

be expected that investors would alter expenditures if relative prices or demand changed significantly six, or even three months before expenditures had been planned.

The model also ignores the influence of capacity, implicitly assuming that the level of excess capacity in the economy at any time is optimal, so that in order to maintain this optimum all changes in output will affect the desired capital stock rather than by being absorbed by any existing capacity. The omission of a capacity variable could be responsible for the rather poor Durbin-Watson statistic (D.W. = 2.54) which indicates that there is possibly negative serial correlation present in the model. The omission of a cyclical variable, namely capacity utilisation is possibly contributing to this problem.

However in spite of its weaknesses the statistical results obtained in the M, F & R study are generally good, so that this model provides a promising starting point for the construction of a New Zealand model.

9. THE CONSTRUCTION OF A NEW ZEALAND MODEL

From Jorgenson's theory (as explained briefly in Section 8), an expression for the desired capital stock is obtained :-

$$i) \quad K^{\#} = a \frac{P}{C} Y$$

where $K^{\#}$ = the desired capital stock

a = the elasticity of output with respect to capital

Y = output

P = the price of output

C = the implicit rental cost of capital.

The actual capital stock will take up to n quarters to adjust to the desired level, so that the actual stock can be expressed as a linear combination of desired levels in the preceding n quarters :-

$$ii) \quad K_t = \sum_{i=0}^n W_i K^{\#}_{t-i}$$

where K_t = the actual capital stock.

From ii) we obtain an expression for net investment :-

$$iii) \quad I_{net} = \sum_{i=0}^n W_i K^{\#}_{t-i}$$

If replacement investment is assumed to be proportional to the capital stock of the preceding period, this can be expressed as follows :-

$$iv) \quad I_{rep} = g K_{t-1}$$

An expression for gross investment is obtained by summing iii) and iv) to give

$$v) \quad I_{gross} = \sum_{i=0}^n W_i \left[a \frac{P}{C} Y \right]_{t-i} + g K_{t-1}$$

* The mathematical derivation of this theory is given in [24] [28]. The theoretical formulae used here are taken from the study by Mackrell, Frisch and Roope [34].

If it is assumed that the elasticity of the desired capital stock with respect to relative prices may be less than one a more general expression can be obtained :-

$$vi) \quad I_{\text{gross}} = \sum_{i=0}^n W_i \left[a(\bar{C})^{E_P} Y \right]_{t-i} + g K_{t-1}$$

where E_P = the elasticity of the desired capital stock with respect to relative prices.

Equation vi) was tested using a range of elasticities (see Table I).

The model was modified slightly by the inclusion of seasonal dummy variables, and a constant term. Although a constant term is not theoretically necessary in this model it was included in the hope that if the model was incompletely specified it would pick up the effect of some of the missing variables. Initial tests of this model were disappointing. In all cases the model was plagued by chronic serial correlation which made it impossible to discriminate with any confidence between the different equations. However the results broadly confirmed the findings of Mackrell, Frishh and Roope with respect to the elasticity of the desired capital stock with respect to relative prices, the model with an elasticity of 0.3 was better in all statistical respects than the other models. In general the lag structures estimated for the desired capital stock term gave significant results, the best results were obtained for a lag distributed over seven quarters.

The preferred equation for the series was :-

$$vii) \quad \text{IMR} = \begin{matrix} .1529\text{ZCS2} & - & .0481\text{SS1} & - & .0302\text{SS2} \\ (3.06) & & (-1.89z) & & (-1.21) \end{matrix} \\ + \begin{matrix} .0011\text{SS3} & + & .0343\text{KMR4} & -1 & + \sum_{i=0}^7 W_i \text{YMR2} \\ (.04) & & (8.40) & & \end{matrix}$$

$$W_0 = 0000$$

$$W_1 = .05693 (2.64) \quad W_5 = .14180 (6.55)$$

$$W2 = .09035 (3.68)$$

$$W6 = .12363 (3.48)$$

$$W3 = .11944 (5.14)$$

$$W7 = .07827 (1.33)$$

$$W4 = .13850 (7.00)$$

$$\bar{R}^2 = .77 \quad \text{S.E.E.} = 5.57 \quad \text{C.V.} = 9.5\% \quad \text{D.W.} = .57 \quad \text{F} = 19.5$$

In estimating lag structures, except where otherwise specified, the Almon technique was used, with a third degree polynomial with the first Almon variable constrained to be zero in order to give the lag structure the theoretically desirable inverted V structure.

The serial correlation suggested that the model was incompletely specified with some important variables missing. In an attempt to remove the serial correlation a number of additional variables were introduced into the model.[⊠] Firstly an obvious potential weakness in the model is the absence of a capacity utilisation variable. To overcome this deficiency an index of capacity utilisation was included in the model. Secondly there are special features in the New Zealand economy which could make a pure theoretical model impractical. In particular the importance of quantitative import restrictions may influence investment spending in New Zealand. To account for this factor a dummy variable was included in the model, a second dummy variable was introduced to account for the United Kingdom dock strike (in the fourth quarter of 1967), which influenced investment in New Zealand. Finally a money supply variable was added in an attempt to capture the effect of the availability of funds on investment. Some reservations were held about the inclusion of this last variable however, because of its collinearity with interest rates which are an important item in the implicit rental cost of capital term.

⊠ At this stage of the project I benefited greatly from the work of R. S. DEane and M. A. Lumsden who generously shared the experience they acquired in the construction of an investment model. [7]

The inclusion of these variables improved the explanatory power of the model, and significantly improved the Durbin-Watson (D.W.) statistic. However this specification was unsatisfactory because some of the newly introduced variables captured the effect of the coefficients on the desired capital stock term, so that this term became totally insignificant. This is not acceptable because this term should theoretically have the dominant influence of investment behaviour. A further indication that the model was incorrectly specified was given by the fact that the coefficient on the capital stock variable, which should be approximately equal to the assumed rate of depreciation on which the capital stock series is constructed, was implausibly high.

At this point the newly introduced variables were dropped from the model one by one in an attempt to isolate the confounding variable. The best results were obtained when the money supply variable was removed. This improved the significance of the weights on the desired capital stock term, although it was apparent that some of the effect of this term was still being attributed to the capacity utilisation and import control variables.

The extended model, excluding the money supply variable, was tested for a range of elasticities (see Table II) and over a wider scan of lags. The favoured model again was that with a lag of seven quarters.

However the introduction of the extra variables confused the results with respect to elasticities. In this test the model with an elasticity of desired capital stock with respect to relative prices equal to zero, was clearly inferior to the other models. However it can be seen from table II that there was little difference between the remaining models, with those having elasticities of 0.5 and 0.8 being slightly superior.

In this situation there are no firm theoretical guidelines to suggest which model is preferable. While it is clear that relative prices have a role to play, and will therefore have an elasticity of greater than zero, it is not possible, from these models to make a precise estimate of the elasticity. In light of the different results obtained from the first series of equations, it is evident that satisfactory estimates of the elasticity of desired capital stock with respect to relative prices cannot be made from this data, since the equations are not sensitive enough to allow discrimination among the various outcomes.

One of the preferred equations for the series was :-

$$\begin{aligned}
 \text{viii) IMR} &= -.8792\text{ZCS2} \quad -.0364\text{SS1} \quad -.0281\text{SS2} \\
 &\quad (2.74) \quad (-1.673) \quad (-1.41) \\
 &+ .0233\text{SS3} \quad + .0296\text{KMR4} \quad -1 \quad -.0362 \text{ZDS} \\
 &\quad (1.13) \quad (7.40) \quad (-1.11) \\
 &+ 1.717 \text{UTC9}_{-2} \quad + 0.452 \text{ZQR} \quad + \sum_{i=0}^7 W_i \text{YMR3} \\
 &\quad (3.54) \quad (2.46)
 \end{aligned}$$

$$W_0 = 0000$$

$$W_1 = -.01291 (-.601)$$

$$W_2 = .00006 (.002)$$

$$W_3 = .01856 (.739)$$

$$W_4 = .03707 (1.654)$$

$$W_5 = .05001 (2.306)$$

$$W_6 = .05185 (1.726)$$

$$W_7 = .03703 (.770)$$

$$\bar{R}^2 = .86 \quad \text{S.E.E.} = 4.321 \quad \text{C.V.} = 7.4\% \quad \text{D.W.} = 1.12$$

$$F = 25.25$$

Although the results from the series of equations are better than those obtained from the basic model, they are still unsatisfactory, as the model is deficient in explanatory power, and serial correlation is still a problem. It is apparent at this stage that it is not possible to construct a satisfactory neo-classical model in the Jorgenson framework with ordinary least-squares estimators, and this particular data.

This specification was therefore dropped and the equation was estimated with separate lag structures on the output and relative price terms. The inverted V type lag structure did not appear to be appropriate for the relative price term, as insignificant results were obtained for most coefficients when this type of lag structure was used. The best results were obtained when a declining structure was used, since relative prices appeared to be highly important in the current year, and to decline in importance thereafter. The preferred equation estimated in this manner had an elasticity of one for the desired capital stock with respect to relative prices. This again emphasised the importance of relative prices near the point of making expenditures.

The favoured equation was estimated as follows :-

$$\begin{aligned}
 \text{ix) } \text{IMR} &= \underset{(-3.08)}{-.0370} \text{SS1} + \underset{(10.09)}{.0248} \text{KMR4}_{-1} \\
 &+ \underset{(10.25)}{.9443} \text{UTC9}_{-2} - \underset{(-2.31)}{.0529} \text{ZDS} \\
 &+ \underset{(3.76)}{.0405} \text{ZQR} + \sum_{i=0}^7 W_1 \text{YR1}_{t-i} + \sum_{i=0}^7 V_i \left(\frac{1}{\text{CCR1}} \right)_{t-i} \quad * \\
 W_0 &= 0000 \\
 W_1 &= .02766 \quad (2.54) \\
 W_2 &= .04199 \quad (3.23) \\
 W_3 &= .05380 \quad (3.93)
 \end{aligned}$$

$$W_4 = .06094 (4.20)$$

$$W_5 = .06128 (3.44)$$

$$W_6 = .05266 (2.09)$$

$$W_7 = .03295 (.90)$$

$$V_0 = -18.72 (-7.74)$$

$$V_1 = -14.33 (-7.74)$$

$$V_2 = -10.53 (-7.74)$$

$$V_3 = -7.31 (-7.74)$$

$$V_4 = -4.68 (-7.74)$$

$$V_5 = -2.63 (-7.74)$$

$$V_6 = -1.17 (-7.74)$$

$$V_7 = -0.29 (-7.74)$$

$$R^2 = .93 \quad \text{S.E.E.} = 3.12 \quad \text{C.V.} = 5.3\% \quad \text{D.W.} = 2.10$$

$$F = 63.7$$

Because of the poor results obtained from the neo-classical approach, the equation ix) above was chosen as the best tested in this study. It is however unsatisfactory theoretically. In particular there is no sound theoretical reason for the different lag structures on the output and relative price terms, in fact a number of studies suggest that relative prices should be a much less important consideration at the point of making expenditures e.g. [3][12], which suggests that the importance of the relative price variable in this model may be partly attributable to the fact that the investment deflator PI is a component of both the dependent and independent variables.

* The constant term did not add to the explanatory power of the equation, so since it is theoretically unnecessary was dropped from the model. The insignificant seasonal dummy variables were also eliminated from the model for similar reasons.

However in other respects the model is theoretically plausible in its indication that businessmen form a desired capital stock, on the basis on demand and relative prices, and that this desired stock is modified at or near the time of making expenditures by such factors as the degree of existing excess capacity and by constraints forced upon them in such forms as import controls and major dock strikes.

TABLE I - RESULTS FROM THE BASIC
NEO-CLASSICAL MODEL

Elasticity of
Desired Capital
Stock with respect
to relative prices.

Coefficients
and t values

	0	0.3	0.5	0.8	1.0
£	0	0000	0000	0000	0000
1	.05338 (2.618)	.05693 (2.643)	.05760 (2.618)	.05576 (2.881)	.05136 (3.031)
2	.08889 (3.732)	.09035 (3.675)	.08396 (3.367)	.07307 (3.335)	.06485 (3.379)
3	.12127 (5.073)	.11944 (5.134)	.10430 (4.520)	.08273 (4.105)	.07074 (3.996)
4.	.14378 (6.132)	.13850 (6.999)	.11531 (6.269)	.08427 (5.372)	.06942 (5.007)
5.	.14967 (5.336)	.14180 (6.549)	.11368 (6.034)	.07732 (4.974)	.06129 (4.451)
6.	.13216 (3.178)	.12363 (3.478)	.09613 (2.910)	.06114 (2.187)	.04675 (1.903)
7.	.08453 (1.338)	.07827 (1.332)	.05933 (1.041)	.03555 (.725)	.02619 (.609)
8.					
KMR4	.0319 (6.899)	.0343 (8.398)	.0362 (8.724)	.0381 (8.741)	.0389 (8.657)
-1					
551	-.0448 -1.586	-.0481 (-1.891)	-.0476 (-1.841)	-.0456 (-1.685)	-.0438 (-1.5759)
552	-.0284 (-1.025)	-.0302 (-1.207)	-.0307 (-1.196)	-.0302 (-1.112)	-.0295 (-1.053)
553	+.0042 (-.145)	.0011 (.044)	.0080 (.307)	.0103 (.606)	.0209 (.755)
ZCS2	.1819 (3.296)	.1529 (3.061)	.1379 (2.685)	.1255 (2.307)	.1217 (2.170)
R ²	.72	.77	.76	.73	.72
S.E.E.	6.180	5.571	5.686	5.983	6.155
C.V.	10.6%	9.5%	9.7%	10.2%	10.5%
D.W.	.48	.57	.54	.49	.47
F	15.02	19.57	18.60	16.34	15.18

£ Numbers 0-7 refer to the weights on the output-relative price terms lagged 0-7 periods.

TABLE II - RESULTS FROM THE EXTENDED
NEO-CLASSICAL MODEL

Elasticity of
Desired Capital
Stock with respect
to relative prices.

Coefficients
and t values

	0	0.3	0.5	0.8	1.0
	0	0000	0000	0000	0000
1	-.01400 (-.863)	-.01186 (-.588)	-.01291 (-.601)	-.00272 (-.148)	.00313 (.204)
2	-.00471 (-.237)	.00277 (.115)	.00006 (.002)	.00618 (.289)	.00990 (.554)
3	.00952 (.435)	.02310 (.926)	.01856 (.739)	.01763 (.849)	.01753 (1.017)
4	.02428 (1.000)	.04313 (1.761)	.03707 (1.654)	.02839 (1.625)	.02406 (1.670)
5	.03514 (1.169)	.05683 (2.120)	.05001 (2.306)	.03524 (2.252)	.02753 (2.128)
6	.03766 (.918)	.05822 (1.604)	.05185 (1.726)	.03494 (1.525)	.02598 (1.344)
7	.02742 (.478)	.04128 (.772)	.03703 (.770)	.02427 (.620)	.01746 (.526)
KMR4 -1	.0292 (7.833)	.0295 (7.752)	.0296 (7.403)	.0305 (7.367)	.0311 (7.528)
ZDS	-.0339 (-.995)	-.0372 (-1.133)	-.0362 (-1.107)	-.0342 (-1.033)	-.0336 (-1.006)
UTC9 -2	1.3458 (3.980)	1.1720 (3.490)	1.1717 (3.541)	1.2375 (3.785)	1.280 (3.940)
ZQR	.0462 (2.809)	.0432 (2.434)	.0452 (2.459)	.0435 (2.395)	.0416 (2.371)
SS1	-.0329 (-1.476)	-.0364 (-1.666)	-.0364 (-1.673)	-.0377 (-1.738)	-.0383 (1.773)
SS2	-.0234 (-1.137)	-.0269 (-1.353)	-.0281 (-1.412)	-.0277 (-1.365)	-.0267 (-1.308)
SS3	.0260 (1.151)	.0222 (1.045)	.0233 (1.135)	.0239 (1.179)	.0245 (1.211)
ZCS2	-1.0361 (-3.159)	-.8797 (-2.720)	-.8792 (-2.745)	-.9485 (-2.978)	-.9942 (-3.138)
\bar{R}^2	.85	.86	.86	.86	.85
S.E.E.	4.505	4.330	4.321	4.385	4.420
C.V.	7.7%	7.4%	7.4%	7.5%	7.6%
D.W.	1.1	1.1	1.12	1.1	1.1
F	22.99	25.14	25.25	24.44	24.01

10. DATA

All data used in this study, with the exception of some of the components of the implicit rental cost of capital were taken directly from the Reserve Bank of New Zealand Database.[‡] The data suffers from a number of weaknesses - in particular the investment series involves some double counting and therefore does not allow a highly rigorous examination of investment theories. However the data generally have given good results in the Reserve Bank's preliminary model of the New Zealand economy, [7] which suggests that it is free from major systematic biases.

The data are defined as follows :-

<u>Database Number</u>	
931	IMR = IM/PI - investment in plant and machinery (real).
930	IM = ICM + WPM - investment in plant and machinery \$M.
2600	ICM = Imports of plant and machinery.
3460	CCR1 [‡] = The implicit rental cost of capital relative to PY1 - elasticity = 1.
3461	CCR2 = The implicit rental cost of capital relative to PY1 - elasticity = 0.3.
3462	CCR3 = The implicit rental cost of capital relative to PY1 - elasticity = 0.5.
3463	CCR4 = The implicit rental cost of capital relative to PY1 - elasticity = 0.8.
	d = 3.5%
935	KMR4 [‡] = $(1-d) KMR4_{-1} + (1-\frac{d}{2}) IMR$ [7 p.25]
	MM1 = money - notes and coin plus demand deposits with trading banks.

‡ Further information on the construction of the data series can be found in 'New Data for Economic Research' by R. s. Deane, D. Grindel and . A. Lumsden [7]

1990	MM1R [⊠]	=	MM1/PC
3674	PC	=	Consumers' price index.
3731	PI	=	Import price index.
1455	PY1	=	Implicit price deflator for Y1
	SS1	=	Seasonal Dummy - March quarter.
	SS2	=	Seasonal Dummy - June quarter.
	SS3	=	Seasonal Dummy - September quarter.
	SS4	=	Seasonal Dummy - December quarter.
3658	UTC9 [⊠]	=	Utilisation of capacity = YR1S/YRC5
671	WTM	=	Wholesale turnover of machinery.
228	YR1 [⊠]	=	Aggregate expenditure, excluding farm stocks, constant 1965 prices.
340	YR1S	=	YR1 seasonally adjusted.
354	YRC5	=	Capacity output.
3654	Y1	=	Aggregate expenditure excluding farm stocks - current prices.
3464	YRM1	=	YR1 x CCR1
3465	YRM2	=	YR1 x CCR2
3466	YRM3	=	YR1 x CCR3
3467	YRM4	=	YR1 x CCR4
	ZCS2	=	Constant.
120	ZDS	=	United Kingdom dock strike dummy (fourth quarter 1967)
102	ZQR [⊠]	=	Quantitative import restrictions dummy.

⊠ All these variables are given in the appendix. The appendix also gives the details of the construction of CCR1.

The Construction of the Implicit Rental Cost of Capital Variable

The rationale for constructing this variable is simply that the market price of investment goods does not provide a true indication of the user cost of capital goods. In order to assess the user cost, factors such as the treatment of investment for taxation purposes, and the opportunity cost of investment as indicated by interest rates, must be incorporated in an expression for the cost of capital.

The following definition, used by Mackrell, Frisch and Roope [p.7] is adapted for this study.

$$\text{The implicit rental cost of capital } C = \left[d(1-UXZ) - (UV) + r(1-US)(1-UXZ) \right] \frac{q}{1-U}$$

where q = the market price of investment goods. For this the import price index (PI) was used as an approximation.

U = the company income tax rate (50% over the sample period).

X = the investment allowance (10% in applicable years).[‡]

Z = the proportion of gross investment qualifying for the investment allowance. For this the amount claimed under the allowance was divided by gross investment. This indicated that approximately 15% qualified for the allowance.

d = the rate of depreciation on capital stock - for this the assumed rate of 3.5% was used.

S = the proportion of the cost of capital deductible for tax purposes. This was approximated by the proportion for companies of external borrowings to net fixed assets using New Zealand public company financial statistics.

r = the cost of funds. The yield on medium term government

‡ The investment allowance was not available between Q3 1963 and Q2 1966.

57.

securities was used for this purpose.

V = the proportion of capital depreciation deductible for tax purposes. This is equal to one in New Zealand.

11. EX-POSTE FORECASTS

In order to examine the potential predicting qualities of the two better equations (VIII & IX) ex-poste forecasts were conducted over the four quarters of 1971 (see diagrams I and II).

Both equations failed to predict the fall in investment expenditures from \$75.64M in 1970 (4) to \$68.18M in 1971 (1), and the estimate of the better equation (ix) of \$74.92M is unsatisfactory. However by 1971 (2) the equations forecast reasonably well as expenditures began to increase again.

The preferred equation (ix) gave the best forecasts. It did not over-estimate investment expenditures by as much in 1971 (1), and it predicted the recovery of investment expenditures sooner than did the neo-classical model.

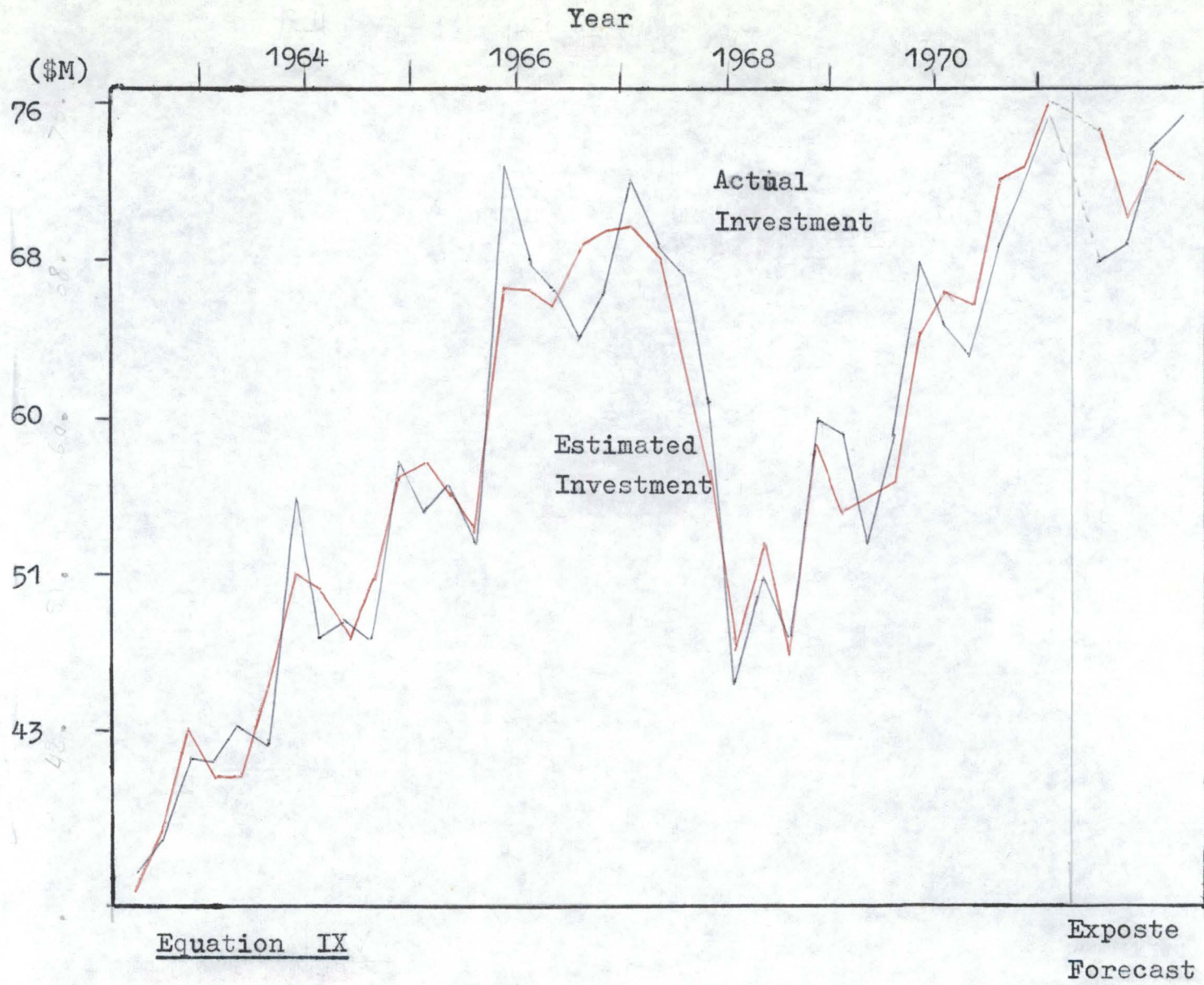
The ex-poste forecasts for 1971 are given as follows :-

1971	<u>Actual Investment (\$M)</u>	<u>Forecast Investment</u>	
		Equation VIII	Equation IX
Q1	68.17	81.33	74.92
Q2	69.20	73.98	70.68
Q3	73.78	78.45	73.27
Q4	75.97	75.50	71.99

Although the equations do not forecast with a high degree of accuracy they appear to be reasonably free from systematic biases which is a satisfying result. It can be seen from diagrams I and II that investment expenditures have been subject to marked fluctuations over the sample period, which makes forecasting difficult. Given the difficulties experienced with data the equations explained these fluctuations very well. In particular equation IX explained the investment boom in 1966 and the subsequent downturn in 1968 in a satisfactory manner. This performance, combined with the ex-poste forecasts, suggests that the models include the more important determinants of investment

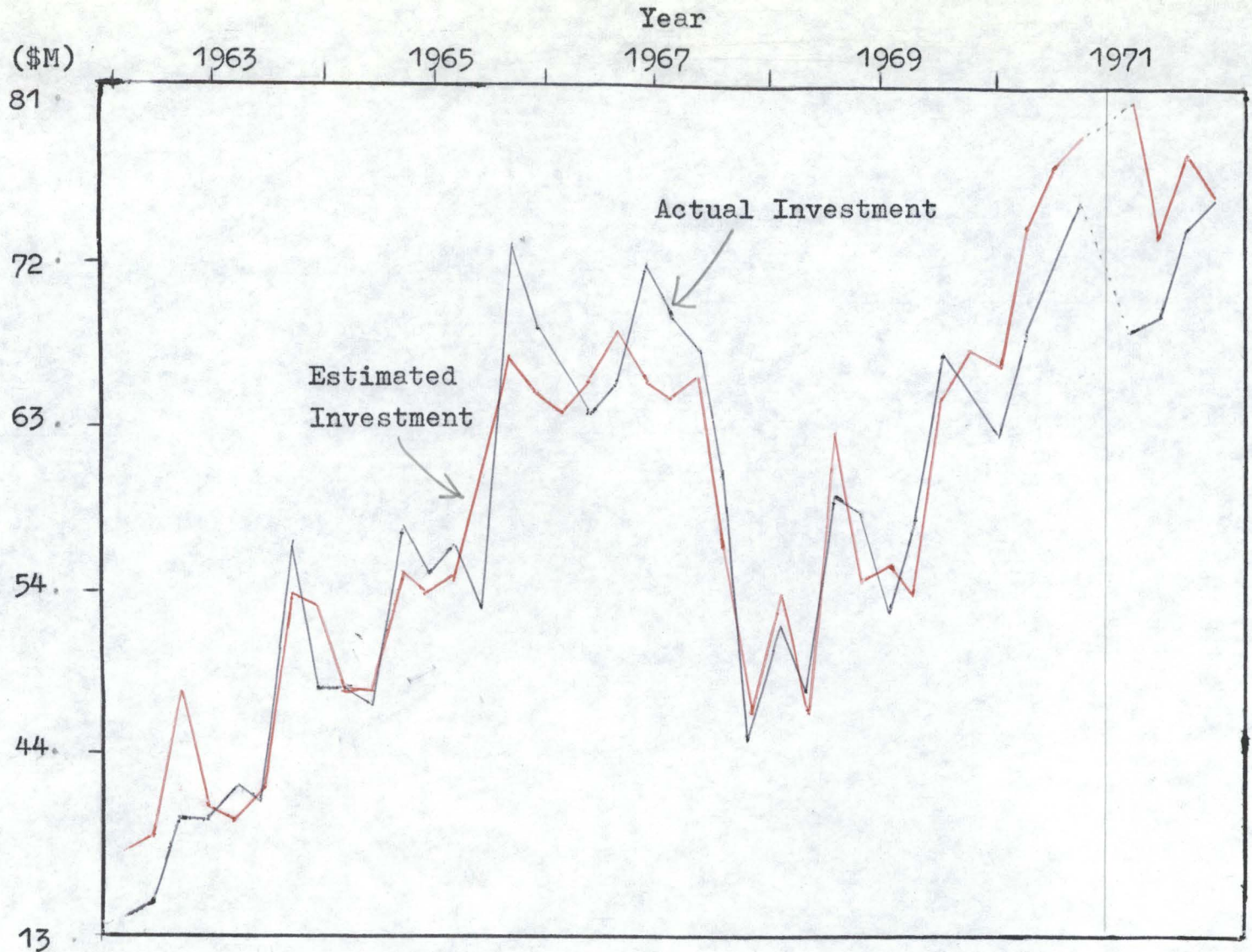
behaviour and that with improved data, particularly for the relative price term and the investment series, would provide satisfactory results.

P.60



GRAPH I

61



Equation VIII

Exposte
Forecast

GRAPH II

12. CONCLUSION

The pure neo-classical theory in the Jorgenson framework did not give adequate results in this study, this demonstrates that there are features of the New Zealand economy which make pure theoretical models unrealistic for this particular situation. However it is evident that the basic theoretical framework is still useful when augmented with variables to account for the special nature of the New Zealand economy. The fact that the preferred model was not in the formal neo-classical framework does not imply that the theory should be rejected. To some extent the poor performance of the theory can be attributed to the data, particularly the investment series, which because of its imperfections always left some doubt as to whether theory or data was responsible for the results obtained, making it difficult to tighten the model's specification.

The implicit rental price of capital variable made a significant contribution to the explanatory power of all models tested. This implies that monetary and fiscal policies, as reflected in interest rates and the taxation structure, have an important influence on investment in New Zealand. However the models tested here were not sensitive enough to give a reliable indication of the size or significance of the effects of particular measures. It is possible that the improvement of this variable would improve the explanation of investment behaviour, and allow more sensitive calculations of elasticities to be made.

The primary purpose of the study was to enable prediction to be made of changes in investment expenditures. The ex-poste forecasts used have indicated that some of the models here would provide a sound basis for predictions in the context of a general equilibrium model. The prior D.W. statistic for some of the models suggests that serial correlation is still present in those cases. However the fact that the equations perform (even if very generally) according to a priori

expectations suggests that the neo-classical approach is valid in the New Zealand situation, and firmly indicates that simplistic explanations of major categories of national expenditure by the use of such practices as classifying categories of expenditure as 'autonomous' or 'induced' as in naive models, are inadequate and have little use for practical purposes. Investment behaviour is clearly affected by a large number of factors, some of which have an influence distributed over a period of almost two years.

13. DATA APPENDIXInvestment in Plant and Machinery (real) ₪

1.	IMR	Q ₁	Q ₂	Q ₃	Q ₄
			31.788	38.894	45.016
3		46.111	46.246	45.129	40.689
		35.169	36.531	41.158	41.009
		42.386	41.668	55.020	48.156
		48.439	47.474	57.024	54.415
		56.391	52.443	73.336	68.098
		66.533	64.029	65.948	72.198
		68.935	67.378	60.472	45.090
		51.382	47.738	59.572	58.522
		53.030	58.449	67.843	64.272
		62.199	68.762	72.419	75.649
		68.179	69.203	73.780	75.975

KMR4 Stock of Plant and Machinery (real) Depr. 3.5% ₪

	Q ₁	Q ₂	Q ₃	Q ₄
		662.490	670.550	685.314
	705.578	726.210	746.253	764.496
	777.735	785.086	793.518	806.203
	818.298	831.323	843.186	867.759
	884.725	901.375	916.494	940.471
	961.045	982.840	999.992	1037.082
	1067.724	1095.756	1120.345	1145.960
	1176.822	1203.396	1227.509	1243.990
	1244.774	1251.716	1254.832	1269.472
	1282.567	1289.806	1302.118	1323.233
	1340.099	1354.840	1375.013	1398.076
	1423.506	1440.669	1458.238	1479.688

UTC9 Capacity Utilisation ₪

	Q ₁	Q ₂	Q ₃	Q ₄
		0000	97.5	95.9
	97.9	93.1	99.6	99.4
	94.6	95.2	92.9	92.0
	94.3	95.1	95.6	95.7
	93.3	93.9	95.5	97.1
	97.1	91.4	96.3	97.7
	98.1	99.4	99.8	99.4
	100.2	98.0	91.2	89.9
	100.2	90.7	96.9	92.3
	91.6	91.6	92.9	95.8
	94.6	98.1	96.1	98.3
	99.0	94.0	95.5	95.1

YR1 Aggregate Expenditure - Excluding Farm Stocks ₹

	734.8	750.4	712.1
724.7	777.8	808.0	715.1
769.6	752.4	776.5	740.4
798.8	800.2	837.7	764.5
821.1	824.1	879.8	830.9
831.1	858.1	914.8	879.3
939.2	918.1	962.7	937.6
963.2	865.3	901.2	905.4
926.2	950.8	960.5	933.4
968.6	944.3	1035.3	1002.9
1073.8	1013.8	1102.7	1089.1
1067.8	1044.9	1109.5	1097.7

ZQR Dummy Variable for Quantitative Import Restrictions ₹

	100	100	100
100	100	-100	-100
-100	-100	0	0
0	0	0	0
0	0	0	0
0	0	100	100
100	100	0	0
0	0	-100	-100
-100	-100	0	0
0	0	100	100
100	100	100	100
100	100	100	100

CCR1 The Implicit Rental Cost of Capital Relative to PY1

	Q_1	Q_2	Q_3	Q_4
		.857	.893	.936
.874		.841	.839	.885
.862		.867	.930	.926
.937		.902	.946	.986
.979		.954	1.030	1.043
1.022		1.002	1.018	1.016
1.008		.983	1.050	1.044
1.079		1.089	1.032	1.011
.870		.907	.927	.912
.918		.909	.949	.932
.974		.940	.955	.995
.982		1.019	.967	1.015

54.

C The Implicit Rental Cost of Capital (index
w $Q_3 = 1.000$)

1960	.982	.997	.967	.933
61	.965	1.004	1.032	1.001
62	1.018	1.015	.968	.985
63	.973	1.014	.989	.974
64	.981	1.014	.963	.971
65	.973	.986	1.000	1.003
66	1.008	1.035	.985	.989
67	.993	1.002	1.039	1.051
68	1.212	1.198	1.189	1.242
69	1.244	1.249	1.227	1.247
70	1.226	1.264	1.277	1.314
71	1.324	1.307	1.411	1.409

S The Proportion of the Cost of Capital Deductible
for Tax Purposes

	Q_1	Q_2	Q_3	Q_4	
1960		.80	.80	.80	
61	.80	.80	.80	.80	
62	.80	.80	.80	.80	
63	.80	.80	.80	.80	
64	.80	.80	.77	.77	
65	.81	.81	.75	.75	
66	.77	.77	.82	.82	
67	.85	.85	.81	.81	
68	.81	.81	.80	.80	
69	.80	.80	.82	.82	
70	.87	.87	.91	.91	
71	.99	.99	.93	.93	⊠

⊠ In this expression external borrowings included the items Bank overdrafts, Creditors, Fixed Charges, Mortgages, Debentures. Data was unobtainable before Q_3 1964, so before this data the ratio was assumed to be constant at 0.8

q (PI) The Import Price Index [⊠]

	Q ₁	Q ₂	Q ₃	Q ₄
1960	1.010	1.025	1.005	.980
61	1.010	1.009	1.025	.987
62	.989	.998	.979	.977
63	.964	1.007	.983	.978
64	.992	1.027	.984	.989
65	1.000	1.005	.998	.997
66	1.008	1.015	.989	1.000
67	1.012	1.013	1.024	1.031
68	1.189	1.176	1.172	1.222
69	1.219	1.224	1.220	1.255
70	1.269	1.308	1.357	1.396
71	1.426	1.419	1.470	1.469

r (JGM) Yield on Government Securities, Medium Term [⊠]

	Q ₁	Q ₂	Q ₃	Q ₄
	4.87	4.87	4.78	4.70
	4.74	5.05	5.14	5.21
	5.32	5.22	5.20	5.16
	5.16	5.14	5.08	4.97
	4.91	4.90	5.75	4.77
	4.86	4.93	4.86	4.89
	4.92	5.06	5.14	5.09
	5.17	5.26	5.29	5.33
	5.32	5.32	5.20	5.22
	5.26	5.25	5.22	5.13
	5.16	5.17	5.14	5.14
	5.31	5.29	5.29	5.29

PY1 The Implicit Price Deflator for aggregate Expenditure
Excluding Farm Stocks [⊠]

	Q ₁	Q ₂	Q ₃	Q ₄
1960		.854	.864	.873
61	.844	.845	.866	.886
62	.877	.880	.901	.912
63	.911	.914	.936	.960
64	.961	.967	.991	1.012
65	.994	.988	1.018	1.019
66	1.017	1.017	1.035	1.033
67	1.071	1.091	1.072	1.062
68	1.054	1.087	1.103	1.133
69	1.142	1.136	1.165	1.163
70	1.195	1.188	1.219	1.308
71	1.300	1.332	1.364	1.431

⊠ All these variables were taken directly from the R.B.N.Z. Database.

B I B L I O G R A P H Y

1. Almon, s. 'The Distributed Lag Between Capital Appropriations and Expenditures.' *Econometrica* Jan 1965 Vol 33 pp.178-196
2. Anderson, W. H. L. 'Business Fixed Investment: A Marriage of Fact and Fancy.' in Feber, R. 'Determinants of Investment Behaviour.' C.V.P. 1967
3. Bischoff, C.W. 'Business Investment in the 1970's: A Comparison of Models.' *Brookings Papers* 1971: 1 pp.13-63
4. Bourneuf, A. 'Manufacturing Investment, Excess Capacity and Rate of Growth of Output.' *A.E.R.* Sept 1966 54(5) pp.607-25
5. Chenery, H. B. 'Overcapacity and the Acceleration Principle.' *Econometrica* Jan 1952 20(1) pp.1-28
6. Clark, J. M. 'Business Acceleration and the Law of Demand.' *J.P.E.* 1917
7. Deane, R. S. and Lumsden, M. A. 'The Determinants of Quarterly Gross Capital Expenditure in New Zealand.' Reserve Bank Research Paper (to be published in Feb 1973)
- 7A. Deane, R. S., Grindell, D. and Lumsden, M. A. 'New Data for Economic Research.' Reserve Bank of New Zealand, Research Paper No. 3 February 1972
- 7B. Deane, R. S. 'Towards a Model of the New Zealand Economy.' Reserve Bank of New Zealand Research Paper No. 1 September 1971
8. Duesenberry, J. S. 'Business Cycles and Economic Growth.' McGraw-Hill 1958 Chs. 485 pp.49-113
9. Eisner, R. 'A Distributed Lag Investment Function.' *Econometrica* Jan 1960 pp.1-29
10. Eisner, R. 'A Permanent Income Theory of Investment Behaviour.' *A.E.R.* June 1967 pp.363-90
11. Eisner, R. 'Investment: Fact and Fancy.' *A.E.R.* May 1963 pp.237-246
12. Eisner, R. and Nadiri, M. 'Investment Behaviour and the Neo-Classical Theory.' *Rev. Econ. and Stats.* Aug 1968 pp.368-82

13. Evans, M. K. 'Macro-Economic Activity.' Chs 4 & 5 pp.73-149
Harper & Row.
14. Evans, M. K. 'A Study of Industry Investment Decisions.'
Rev. Econ. and Stats. May 1967 pp.151-64
15. Evans, R. G. and
Helliwell, J. 'Quarterly Business Capital Expenditures.'
Bank of Canada Research Studies No. 1 1969
16. Fisher, I. 'The Theory of Interest.' 1930 Sentry Press,
New York.
17. Friedman, M. and
Meiselman, D. 'The Relative Stability of Monetary Velocity
and the Investment Multiplier in the United
States 1897 - 1958.' C.M.C. Research Papers
P - H 1964.
18. Harrod, R. F. 'Towards a Dynamic Economics.'
(London: Macmillan 1948)
19. Hicks, J. R. 'Mr Keynes and the "Classics"; A Suggested
Interpretation.' Econometrica 1937. Reprinted
in Mueller, M. G. 'Readings in Macro-Economics
(H.R. & W.) pp.137-145
20. Johnson, H. G. 'The "General Theory" after Twenty-Five Years.'
In 'Money Trade and Economic Growth.' (Unwin)
pp.126-147 1961
21. Johnston, J. 'Econometric Methods' 2nd Ed. New York,
McGraw-Hill (1972)
22. Jorgenson, D. W. 'Econometric Studies of Investment Behaviour:
A Survey.' J.E.L. Dec. 1971 pp.1111-1147
23. Jorgenson, D. W. 'Capital Theory and Investment Behaviour.'
A.E.R. May 1963 pp.247-259
24. Jorgenson, D. W. 'The Theory of Investment Behaviour.' In
Ferber, R. 'Determinants of Investment
Behaviour.' C.V.P. 1967 pp.129-155
25. Jorgenson, D. W. 'Anticipations and Investment Behaviour.'
In Duesenberry, J. S., Kuh, E., Fromm, G.
and Klein, L. R. (eds) 'The Brookings Quarterly
Model of the U.S. Chicago Road McNally 1965
pp.35-94
26. Jorgenson, D. W.
Hunter, J. and
Nadiri, M. 'A Comparison of Alternative Econometric
Models of Quarterly Investment Behaviour.'
Econometrica, March 1970 pp.187-212

27. Jorgenson, D. W.,
Hunter, J. and
Nadiri, M. 'The Predictive Performance of Econometric
Models of Quarterly Investment Behaviour.'
Econometrica March 1970 pp.213-224
28. Jorgenson, D. W.
and Stephenson, J.A. 'Investment Behaviour in U.S. Manufacturing.'
Econometrica April 1967 35 (2) pp.169-220.
29. Keynes, J. M. 'The General Theory of Employment, Interest
and Money.' MacMillan 1964
30. Koyck, L. M. 'Distributed Lags and Investment Analysis.'
North Holland Publishing Co. Amsterdam 1954
31. Knox, A. D. 'The Acceleration Principle and the Theory of
Investment: A Survey.'
Econometrica 1952 reprinted in Mueller, M.G.
'Readings in Macro-Economics H.R. & W.
pp. 114-136.
32. Kuh, E. 'Theory and Institutions in the Study of
Investment Behaviour.' A.E.R. May 1963
pp. 260-268
33. Lewis, S. D. 'Factor Input Demand and Implied Production
Functions.' Applied Economics March 1972
Vol. 4 No. 1
34. Macreell, N. C.,
Frisch, J. and
Roope, P. 'Equations for Business Fixed Investment.'
Reserve Bank of Australia Occasional Paper
No. 3E, Ed. Norton, W. E. June 1971
35. Mayer, T. 'Plant and Equipment Lead Times.' Journal
of Business April 1960 pp.127-32
36. Mayer, T. and
Sonenblum, S. 'Lead Times for Fixed Investment.' Rev. Econ.
and Stats. Aug. 1955 pp. 300-304
37. Meyer, J. and
Glauber, R. 'Investment Decisions, Economic Forecasting
and Public Policy.' Boston: Division of
Research, Graduate School of Business
Administration, Harvard University 1964
38. Meyer, J. and
Kuh, E. 'The Investment Decision.' Cambridge, MA:SS:
Harvard University Press 1957
39. Modigliani, F. and
Miller, M. H. 'The cost of Capital, Corporation Finance, and
the Theory of Investment.' A.E.R. June 1958
pp. 261-97

40. Resek, R. W. 'Investment by Manufacturing Firms: A Quarterly Time Series Analysis of Industry Data.' Rev. Econ. and Stats Aug. 1966 pp. 322-33
41. Staples, C.A. 'A Guide to New Zealand Income Tax Practise.' Sweet & Maxwell (N.Z.) Ltd
42. Tinbergen, J. 'Statistical Evidence on the Acceleration Principle.' Economica May 1938 pp.164-76

Abbreviations Used :-

1. J.P.E. - Journal of Political Economy.
 2. A.E.R. - American Economic Review.
 3. Rev. Econ. and Stats. - Review of Economics and Statistics.
 4. J.E.L. - Journal of Economic Literature.
-