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TAXATION, COST OF CAPITAL AND INVESTMENT
IN AUSTRALIAN AGRICULTURE

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*The concept and measurement of cost of capital is developed
to include particularly the role of taxation in investment
behaviour. The relative importance of factors influencing
investment in plant and machinery are examined for five
sectors which make up the broadacre industry of Australia.
It is shown that residual funds are important in determining
plant and machinery investment, but not through the normally
hypothesised channels. It is not the increased liquidity
from increased income which raises investment, but the fall
in the cost of capital, which is associated with the
marginal rate of tax.*

Introduction

The paper further develops the model proposed by Lewis, Hall and Kingston (1986) in which important roles were assigned to residual funds and the cost of capital in determining farm investment in plant and machinery. Here the concept and measurement of cost of capital is developed to include particularly the effect of taxation. The relative importance of factors which influence investment decisions are examined for five sectors which make up the broadacre industry of Australia: wheat, mixed livestock/crops, beef, sheep and sheep/beef. The period of analysis is from 1978 to 1985.

Though Australian broadacre properties are generally characterised by the extensive nature of farm operations, there are large differences between the various sectors in the nature and function of capital assets. Different inputs are required for different enterprises. As well, economic and physical depreciation rates vary among items of capital equipment. Thus, depending upon the particular asset and the specificity of that asset to particular broadacre industries, the pattern of investment will vary across the sectors. Investment patterns might further be modified by perceptions of risk within particular sectors. In short, in the analysis of investment behaviour within the broadacre industry there is a case for treating the sectors as separate entities.

In the present study of farm investment, attention has been concentrated on the acquisition of capital assets which originate from the non-farm sector - that is, plant and machinery. The main reason for this is to focus on what is seen as a particularly important component of investment. This is because plant and machinery investment provides a powerful link between the farm sector and the rest of the economy. In addition, the relatively short life of plant and machinery means that changes in such investment are likely to have fairly rapid effects on capital stocks.

Much investment work in Australia has concentrated on testing the 'residual funds' hypothesis of Campbell (1958), who argued that funds generated on-farm were of major importance in the formation of capital. These funds were defined as a 'net income from current operations, less tax commitments and some conventional allowance for farm family living expenses'.

The results of testing the residual funds hypothesis have not, however, been entirely satisfactory. Subsequent investigations have therefore concentrated on developing a more powerful explanatory model, and on improving the definitions of various estimating terms. The empirical studies in Australia are those of Gruen (1957), Herr (1964), Glau (1971), Fisher (1974) and Waugh (1977a and b). The broad issues have been discussed by Powell (1982) and more recently by O'Mara (1985).

Model Specification

Lewis et al. (1986) developed a model in which optimal capital stock, K^*, was assumed to be determined by profit maximisation subject to a neoclassical production constraint. Thus:

(1) $K^* = f(PR, PP, OC)$

where PR is an index of expected prices received, PP is an index of expected prices paid for other inputs (excluding machinery) and OC is the opportunity

cost of capital. This concept is further discussed by Jorgenson and Stephenson (1967), Coen (1975), Fisher (1974) and Vanzetti and Quiggin (1985).

The adjustment process by which operators move to a position of optimal capital stock is modelled using a partial adjustment mechanism:

$$(2) \qquad K_t - K_{t-1} = \mu (K_t^* - K_{t-1}) \qquad 0 \le \mu \le 1$$

where K_t is closing capital stock and K_{t-1} is opening capital stock.

It is assumed that the rate of adjustment toward a desired capital stock is governed by the capacity of an operator to borrow funds and the availability of internally generated funds (IN). Thus:

$$(3) \qquad \mu = g(IN, EQ)$$

where EQ is the ratio of equity to total capital.

Depreciation is assumed to be a constant proportion (σ) of opening capital. Gross investment (I) is therefore:

$$(4) \qquad I_t = \mu K_t^* - (\mu - \sigma)K_{t-1}$$

Thus gross investment I_t is a function of variables determining optimal capital stock and the opening capital stock. Lewis et al. (1986) identified machinery prices, prices of other inputs, interest rates and investment allowances as important determinants of the desired rate of investment in plant and machinery.

Combining (1), (3) and (4) the investment function to be estimated can be written:

$$(5) \qquad I_t = F(PR_t, PP_t, OC_t, IN_t, EQ_t, K_{t-1})$$

In calculating an index of the cost of capital (OC), the effects of investment and depreciation allowances and of the marginal rate of taxation are considered. In general,

$$(6) \qquad OC = h(PM, IR, IA, DA, MT)$$

where
    PM = market price of capital items,
    IR = interest rate,
    IA = investment allowance,
    DA = depreciation allowance, and
    MT = marginal rate of taxation.

The cost (R) of investing one dollar is determined by the relevant allowances - depreciation and investment - and the marginal tax rate:[1]

$$(7) \qquad R = 1 - (IA + DA)MT.$$

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[1] The current depreciation allowance and marginal tax rate are used as approximations to the present values of the streams of expected values of these variables. The validity of this approximation is tested later in this paper by considering various discount rate assumptions.

To obtain an index of the opportunity cost of capital, this was multiplied by the interest forgone and an index of the price of machinery. Thus,

(8) $OC = PM(1 - (IA + DA)MT) IR(1 - MT)$.

In (8), the marginal rate of taxation explicitly changes the opportunity cost of capital. The role of taxation in investment decisions has not figured prominently in most studies. In fact Samuelson (1964) showed that in a perfect capital market, if the tax-deductible depreciation allowance is equal to economic depreciation a firm's investment decision is not affected by income taxation.

So long as economic depreciation is tax-deductible, the tax system will continue to be neutral when marginal tax rates between farm firms differ, providing that the marginal tax rate for each firm remains constant over time. This is because the marginal tax rate applied to expected returns will be equal to the marginal tax rate applied to the calculation of cost of capital.

However, for agricultural investment, fluctuations in the marginal tax rate of each farm firm through time are critical factors influencing the rental price of capital. For all farm firms, the rental price of capital after-tax is lower in years when a firm has a relatively high marginal tax rate, associated with high income, making investment at these times more profitable. Thus fluctuations in a firm's marginal tax rate over time exert a major influence on a firm's optimal time pattern of investment.

Data and Estimation

The data for this analysis were from the BAE's Australian Agricultural and Grazing Industries Surveys, which are described in BAE (1987). In summary, the surveys are of representative samples of commercial farms in Australia which produce beef, wool, sheepmeat and cereals. These are defined as establishments in the Australian Standard Industrial Classification groups 180 to 186 with an Estimated Value of Agricultural Operations greater than $10 000. In March 1985 this population accounted for 91 000 out of an estimated 141 000 commercial farms in Australia, and for nearly two-thirds of all farm production.

The observations used were state averages by industry for the years 1977-78 to 1984-85. (Detailed investment data were not available for more recent years at the time of carrying out the analysis.) Estimates were made for each industry separately because it was expected that their investment behaviour would differ.

A panel of eight years' data was formed for each industry based on state averages for that industry. For example, the wheat estimates are based on five state observations for each of eight years: a total panel of 40 observations. States in which particular industries were insignificant were omitted from the analysis for that industry. The model was estimated using a method developed by Fuller and Battese (1974) for linear models combining cross-section and time series data. This method yields unbiased generalised least squares estimates from panel data.

Investment (I) was defined as net capital spending on plant and machinery by survey farms; this is a measure of gross investment, as no account is taken of depreciation. Opening capital (K_{t-1}) was the opening value of plant and machinery capital, calculated as the depreciated value of

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the capital on hand valued at current replacement costs. The equity ratio
variable (EQ) is defined as the difference between total farm operating
capital and debt as a proportion of total farm operating capital.

The cost of capital index was calculated using equation (8) from series
on expected price of machinery (PM), expected interest rates (IR), the
values of investment allowances (IA), depreciation allowances (DA) and
marginal tax rates (MT). The marginal tax rates (MT) were estimated using
the appropriate income tax schedule for each year. It was assumed that the
farm income of family farms (BAE 1987) represented taxable income of the
farms before capital expenditure and personal deductions. It was further
assumed that this income would be shared equally among all family workers on
the farms.

Taxable incomes were estimated for each sample farm and appropriate
marginal tax rates calculated for each year. Average marginal tax rates were
then obtained by averaging the tax rates of individual farms on a
state-by-industry basis for each year. There was substantial variation in
marginal tax as calculated between years, states and industries.

An expected machinery price series was derived by ARIMA modelling (Lewis
et al. 1986) of the BAE index of the prices paid for machinery. Expected
prices received indexes (PR) were derived by first making ARIMA forecasts of
price indexes of wool, sheepmeat, beef and cereal prices and then forming a
total index according to the weight of each product in average farm receipts
in 1984-85, for each state and industry. The expected interest rate index
(IR) was generated from the annual interest rates for major trading bank
advances. The cost of capital index appearing in the regression equations
was deflated by the expected prices received index. Expected prices of other
inputs were derived in a similar way to those for machinery and similarly
deflated by the expected prices received index.

Results

Each equation was estimated using the complete set of independent
variables and re-estimated to include only those variables whose
coefficients were significantly different from zero at the 5 per cent
level.[2] These preferred equations are given in Table 1.

The industry for which the full model most nearly approximated
investment behaviour was wheat. The preferred equation explains almost 80
per cent of the variation in total investment. Opening capital, income,
equity ratio and cost of capital were all significant and had the expected
signs. The results suggest that investment falls when the cost of capital is
high and rises with income and equity ratio. The income coefficient is,
however, very low - certainly much lower than would be expected from a
traditional interpretation of the residual funds hypothesis.

For the beef industry the preferred equation provides a satisfactory
explanation of farm investment, with both the coefficients of opening
capital and the cost of capital index being significant at the 5 per cent

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[2] The sensitivity of the results to different discount rate assumptions was
tested by estimating each equation with rates varying between zero and
infinity. In no case did the choice of discount rate affect the significance
of coefficients, and in the preferred equations the average range of
coefficient values was less than 5 per cent.

level. Other variables, income, the equity ratio and the relative prices of other inputs, were found to have no independent influence on farm investment.

TABLE 1

Regression Results for Investment Functions(a)

Wheat

$-4.26 + 0.69 \log K_{t-1} + 0.07 \log IN + 1.56 \log EQ - 0.35 \log(OC/PR)$

(1.02) (5.90)   (3.82)   (2.14)   (1.91)

$\bar{R}^2 = 0.78$

Beef

$-0.59 + 1.12 \log K_{t-1} - 0.54 \log(OC/PR)$

(0.35) (8.54)   (2.11)

$\bar{R}^2 = 0.61$

Sheep

$0.003 + 0.46 \log K_{t-1} + 2.25 \log(PP/PR) - 1.47 \log(OC/PR)$

(0.001) (2.60)   (1.99)   (2.55)

$\bar{R}^2 = 0.21$

Sheep-beef

$3.04 + 0.83 \log K_{t-1} - 0.72 \log(OC/PR)$

(1.06) (3.50)   (3.04)

$\bar{R}^2 = 0.32$

Mixed livestock-crops

$4.35 + 0.68 \log K_{t-1} - 0.65 \log(OC/PR)$

(2.01) (3.50)   (4.02)

$\bar{R}^2 = 0.45$

(a) t-statistics in parentheses.

The results for the sheep industry were disappointing in that the hypothesised model did not satisfactorily explain variation in the data. Among the factors which might have contributed to this low $\bar{R}^2$ is the nature of capital in the sheep industry. An important component of farm capital is fixed e.g. fencing, watering points, shearing sheds and yards. Fixed capital was explicitly excluded from this model. Another factor is the low level of investment expenditure on plant and equipment relative to total farm costs. The performance of the model for the sheep industry has implications for the results in other industries, which are discussed later in this section.

Despite the relatively low $\bar{R}^2$, the coefficients of opening capital, relative prices of other inputs and the cost of capital index were all significant at a level of 5 per cent. The coefficient of the income variable was not statistically significant, and income was not included in the preferred form. The explanatory power of the full model, before the rejection of income and the equity ratio to determine the preferred estimating form, was relatively poor.

The preferred equations for both the sheep/beef and mixed livestock/crops industries provided only a limited explanation of the investment process. It is likely however that the sheep activities on these farms are the reasons for the low $\bar{R}^2$. What remains consistent for these two industries, and indeed for the five industries investigated here, is that income can be ascribed no independent role in the determination of farm investment.

The most interesting features of these results overall are the predominant role played by the cost of capital index and the relative unimportance of income. This suggests a different interpretation of the nature of the relationship between investment and residual funds than that suggested by Campbell (1958). An increase in residual funds increases investment, not because of the increased liquidity but because of the fall in the cost of capital, associated with a higher marginal rate of tax.

The generality of the findings of this study must be qualified by a number of limitations. These include the restriction to plant and machinery investment, the restriction to the broadacre industries and the omission of tax averaging. The last is probably the most important from the standpoint of economic theory, since it affects the marginal tax rates payable and hence the user cost of capital.

Conclusion

The qualifications above indicate the need for further analysis in this area, but the results of this study clearly suggest that user cost of capital is a major determinant of new investment in plant and machinery in Australian broadacre agriculture. An important determinant of the cost of capital is the marginal rate of taxation payable on income. Consequently, farm income is itself an important determinant of cost of capital, and hence of investment. This explanation of farm investment contrasts with the traditional residual funds hypothesis, in which income as such is viewed as a determinant of investment. This paper contributes to the debate on the role of residual funds by providing an explanation for the previously observed correlations between income and investment. The results of this study show that for plant and machinery, the nature of farm investment is not markedly different from that which would be suggested by traditional economic theory, in contrast to the views expressed by supporters of the residual funds hypothesis.

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