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The Influence of Credit on Farm Growth

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This study was based on the hypothesis that lenders to the rural sector have the potential to affect the rate of agricultural adjustment directly via capital formation. Multi-period linear programming models were developed to quantify the effects of lender policy on farm growth for wheat growing, dairy and sheep properties. Three basic models were used to represent different farm management types for each industry group of models. The models included the production, marketing, taxation, consumption and investment subsystems of the farm. Emphasis in these models was focused on the financial linkages between these various subsystems. In particular, the models investigated the effects of increases in trading bank credit on farm growth.

1. Introduction

In this study, farm growth is taken to mean increases in the real, discounted value of the farm business. This includes the present value of terminal net worth of the farm firm and discounted consumption by the farm household. In an accounting sense, net worth can be increased either by increasing the value of assets, or by decreasing the value of debt outstanding. Without outside equity financing, this adjustment can only be achieved from capital gains or by the use of retained earnings, after drawings for consumption and taxation. In some circumstances it may be possible to accelerate the adjustment process by reducing consumption or taxation.

To achieve capital gains, the farmer must purchase resources that the market will value later at a greater price than he paid. Farmers can use a variety of methods to increase farm income and profitability. Commonly, these include a more efficient allocation of the present bundle of resources and the adoption of new technology. New technology frequently involves investment in additional resources.

Another method of increasing earnings (and also perhaps capital gain) is to acquire control over additional resources, the discounted returns from which are greater than discounted costs. These resources may be purchased or rented. Purchasing or renting resources, using either cash or credit, should not change the economic concept of net worth in the short term. Traditional accounting concepts would show a decrease in net worth following the rental of a resource, but in economic terms an asset (i.e., the right to use the resource) is created. This apparent conflict between accounting and economic concepts does not occur where a resource is purchased, as asset structure only changes. Again, using economic concepts, if resource purchase or rental is financed by debt creation, net worth should also remain unchanged in the short term.

In the longer term, however, net worth can be increased by acquiring control of more assets, as long as it is profitable to do so in the net present value sense. This process should continue until some constraint is reached. The constraint may be physical, managerial or financial.

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The aim of the present research is to determine the effects of credit on farm growth, using a series of multi-period linear programming models. Results from previous research facilitated the specification of borrowing activities in these models (see Baker 1968; Ockwell 1979; Ockwell and Batterham 1980). Model specification emphasised the interrelationships that exist between the financial subsystem of the farm business and the activities of production, marketing, taxation, consumption and investment. In particular, given the relative importance of the trading banks as institutional lenders to the rural sector, the main thrust of the borrowing block was directed toward credit from the trading banks. The specification of these models and their results are discussed in the following sections.

2. Modelling Farm Growth

Investment and production theory suggest a range of goal functions for the farm. The choice of an appropriate objective function depends on the goals and preferences of decision makers. The specification of goals as part of an overall objective function is constrained, in part, by the identification and quantification of goals of individual decision makers for incorporation into a programming framework.

From a study on micro goal functions, Smith and Martin (1972) concluded that goals other than simple profit maximisation influenced the actions taken by decision makers. From research into multiple-goal objective functions, Harman *et al.* (1972) suggested that several goals affected the decision-making process of farmers. They concluded that two of these goals, the attainment of a higher standard of living and an increase in the net worth of capital assets, were most important.

The recognition by Cocks and Carter (1968) of a dynamic framework through the planning period of the Hicksian model represented a departure from the static analysis of profit maximisation under neoclassical theory. By extending the Hicksian model of profit maximisation to a multiple-goal objective function incorporating elements of consumption and investment, Cocks and Carter attempted to show the relationship between the theory of production and the theory of investment (see also Cocks 1965). This was consistent with the view of Lutz and Lutz (1951) who questioned the appropriateness of static analysis for investment planning.

The derivation of a consumption-investment framework for the decision maker by Cocks and Carter gravitates toward Fisher's approach to investment theory (see Fisher 1954). Extension of Fisher's approach by Hirshleifer (1965) to an asset-wealth approach is applicable to the specification of an objective function of the farm firm (see also Hirshleifer 1970). The inclusion of net present worth as a goal for the financial management of the farm firm was supported by Solomon (1963). Solomon was also in agreement with Hirshleifer (1961) on the choice of the net present value approach for evaluating investment alternatives.

Renborg (1970, p. 52) defined the growth process of the farm firm as a process in time where the decision maker selects growth directions according to some goals. Since actions are selected from a range of possible alternatives to achieve some desired goal, the objective function of the decision maker effectively defines the growth direction.

Penrose (1959) suggested that growth opportunities are either internal or external to the firm. She identified three principal opportunities for growth from sources within the firm. First, all firms include at least some resources which are not employed to their limit as a result of indivisibility of factor inputs (e.g., tractors, implements, shearing sheds). Second, changes in the product mix of firms may render some resources without application under alternative forms of organisation, while some resources previously unemployed may be brought into use as a result of such changes. Third, improvements in the abilities of managers through time may lead to a more efficient use of resources.

External opportunities for growth identified by Penrose which are applicable to the farm include growing demand for particular products, changes in technology which call for large-scale production, and discoveries and inventions whose exploitation seems particularly promising. They also include changes which might adversely affect a farm's existing operations and against which it could protect itself through expansion in particular directions, and diversification of final products to spread risk (Penrose 1959, p. 65).

In establishing the effect of credit on farm growth in the present study it was considered necessary to develop multi-period models which incorporated various subsystems within the farm. The general mathematical form of the model was defined by a linear objective function subject to a series of linear constraints (see Roberts and Schulze 1973; Beneke and Winterboer 1973).

3. Methodology

In an earlier stage of this research, two surveys of lenders derived estimates of the amount of credit available through a series of related farm growth situations. These surveys used simulated loan proposals and were based on specific farm situations which were also used in the farm growth models. The surveys and their results were reported in Ockwell (1979) and Ockwell and Batterham (1980).

The initial intention was to use the survey derived estimates of credit available in the farm growth models to produce a complete response surface linking lenders' loan recommendations with resultant modelled farm growth. However, this approach proved to be too expensive, given the limited computing budget available for the research. Thus, to achieve the second research objective, the initial constraint on trading bank credit was set at $0 and increased to $100,000 by $20,000 increments for each farm growth model.

A series of nine multi-period linear programming models was developed for each of dairy, sheep and wheat farms in New South Wales. These were solved to achieve the research objectives of the farm models, namely:

- to integrate the lending policies of financial institutions supplying credit to agriculture into the financial subsystems of the farm; and
- to determine the way in which credit availability affects farm growth.

Linear programming provides a particularly useful method for integrating the lending policies of financial institutions into a financial subsystem of a farm model. This is achieved by the specification of a credit profile within the model (Baker 1968). A multi-period linear programming model can be used to show how credit availability influences farm growth (Smith and Baker 1969). Further, linear programming models are relatively efficient when compared to other methods of examining the farm growth process.

The major and well known difficulty with standard single period or multi-period linear programming models is that risk is not considered. This difficulty can be overcome in varying degrees, using a variety of alternative models and solution methods. Many of these are reviewed by Anderson, Dillon and Hardaker (1977).

In a multi-period linear programming model, assuming conditions of certainty, it may be argued that, providing it is profitable to do so, credit absorption proceeds at a maximal rate. That is, credit is reserved in any year for either of two reasons: first, the rate of return from subsequent investment alternatives available in a given year are less than the cost of borrowing, and second, the possibility exists that such reserves are required to finance investments in following years (e.g., the replacement of machinery). Given the assumptions underlying the use of linear programming, and those pertaining to the specification of activities contained in particular growth models, the choice of an objective function determines the growth path that is optimal to the solution set. The effect of external credit rationing on farm growth is realised under such conditions.

The role of internal credit rationing in farm growth was not included in the growth models. Barry (1970) incorporated risk into models of farm growth by assigning values to unused credit. These credit reservation prices were assumed by Barry to represent particular levels of risk-aversion (internal credit rationing) characteristic of individual decision makers (see also Barry and Baker 1971). However, such a procedure assumes prior knowledge of borrowers' attitudes to credit use and risk.

The objective function assumed for the farm models was the maximisation of the present value of terminal net worth and discounted consumption. This followed from the Fisher and Hirschleifer approach outlined earlier. Such an objective function was also consistent with the views of Cocks (1965), Cocks and Carter (1968), and the applied research of Boehlje and White (1969), Barry (1970), Vandeputte (1970), and Batterham (1971).

A 15-year planning horizon was used for the model. In common with the studies of Stewart (1961), Irwin (1961), Irwin and Baker (1962), and Taplin (1966), emphasis was focused on the effect of seasonal cash flows on the availability of, and the demand for, capital. Hence, each year of the planning horizon was specified in terms of quarters (three-month periods). This generated 60 periods in the model, with each year representing a July-June financial year. Detailed specification of all activities continued for the 15 years. A 10 per cent time preference factor was used to estimate present values. One model for each farm type was varied for discount rates of 5 per cent and 15 per cent.

For each industry, three models were constructed in an effort to reflect variations in managerial ability of farmers (superior, average and inferior). These variations were modelled using different cash flows in the production and marketing activities.

In order to draw comparisons between the various farm models, the commencing value of land was held constant at $96,000 across the three industry types and across the three levels of farm management within each industry. This avoided the possibility of biasing the values of the objective generated by corresponding injections of trading bank credit.

4. Specification of Farm Models

4.1 Common subsystems

4.1.1 Trading bank credit

Three trading bank loan activities were included in all models: first, an overdraft facility, second, a 10-year term loan, and third, a farm development term loan of 15 years. While the option to borrow on overdraft or via the 10-year term loan was available in every year, borrowing on the farm development term loan was available only in years 1, 5, 8 and 11. There was no constraint on the type of loan according to loan purpose. The specification of these activities was the same for all industry models. Land purchase activities contributed land valuation units which were convertible into trading bank credit at a ratio of 2:1 through a transfer activity. This reflected a common requirement by trading banks that borrowers retain at least 50 per cent equity in their land. Trading bank borrowing activities were available in the first quarter of each year.

Borrowing on overdraft was available on a yearly basis. At the same time, it was possible for a farmer to refinance the overdraft and to continue borrowing in this way provided that trading bank credit was available. Interest payments on overdraft loans were included under the income tax row for the year in which the overdraft was repaid. Hence, borrowing on overdraft was also constrained by the farmer's repayment capacity in the following year. Loan repayments and interest commitments reduced the farmer's disposable income for consumption.

The extent of borrowings under the term loan arrangements was constrained by the amount of trading bank credit available and the farmer's capacity to meet debt commitments as required. Since all borrowings reduced the farmer's level of disposable income in the year in which debt commitments were due, the level of borrowings was also constrained by the requirement that at least subsistence consumption had to be met each year.

Term loans also absorbed trading bank credit and land valuation units in years following the year in which funds were borrowed under such arrangements. This constraint ensured that further credit (e.g., to finance the purchase of additional land) beyond normal overdraft requirements was not made available, until at least 70 per cent of the initial amount borrowed had been repaid.

Under the above specification with trading bank credit initially set at $0, additional land could only be acquired through internal financing. By acquiring more land in this way, it was assumed that the firm had the ability to generate credit through land purchased and hence, was then in the position to finance firm expansion through borrowings. Under the initial specification of the model, land was a restraint to increased production. On this basis, the rate of increase in land operated by the farmer represented a reasonable measure of the rate of farm growth.

4.1.2 Off-farm investment

Two alternative forms of off-farm investment were included in all models: first, a savings bank activity, and second, a trading bank fixed deposit activity. A non-interest bearing cash transfer set of activities was also included in the models to represent a farmer's current account with the trading bank. Interest earned on off-farm investment was included under the income tax assessment row and disposable income for consumption row in each year. There were no disinvestment activities included in the models whereby the farmer had the option to sell the farm and invest his assets outside of agriculture.

4.1.3. Taxation

The specification of the taxation subsystem was based on that suggested by Vandeputte and Baker (1970). Estimation of taxation obligations in the present study was based on the provisions of the *Australian Income Tax Assessment Act*, 1936, with amendments. Taxable income was assessed as gross income less allowable deductions. Taxation liabilities were based on the assumption of an equal income sharing, husband and wife partnership. This was consistent with the form of property organisation documented in the loan proposals of the factorial experiment (Ockwell and Batterham 1980). The taxation rates and brackets used in the models were relevant for the 1975–76 financial year, i.e., year 1 of the models.

Taxable returns included receipts from the sales of farm produce and interest earned on off-farm investments. Deductions included cash costs of production, unallocated expenses, depreciation, allowances for investment in new plant and equipment, interest paid on loans and allowable deductions for personal expenditure. Unallocated expenses included costs which could not be attributed solely to either individual production or marketing activities and were specified in the models as bounded activities.

Depreciation on plant and equipment was based on the diminishing value method as provided for under Australian taxation legislation. An investment allowance of 40 per cent for taxation purposes was allowed on tractor and equipment purchases before 30 June, 1979. After that date, the investment allowance was to continue for 3 years at a reduced rate of 20 per cent. The specification of the investment activities in the wheat models incorporated these provisions relating to the investment allowance.

An income tax accounting equality ensured that taxation obligations were met at their minimum level. Assessed taxable income filtered through the income tax brackets specified according to the taxable income equality, and paid tax on an amount equal to that required under the equivalence of the two plus that proportion required on the residual according to the following higher tax bracket. An increasing marginal propensity to tax schedule was specified in accordance with the progressive income tax system. Taxation obligations were met through cash withdrawals in the fourth quarter of each financial year. Such obligations also reduced the level of disposable income for consumption by the same amount.

Several provisions of the Income Tax Assessment Act were omitted from the taxation subsystem to avoid increasing the complexity of the models. These provisions related to livestock valuations, income tax averaging, income equalisation deposits and provisional taxation (see Mannix and Harris 1974). Tax averaging, in particular, would be extremely difficult to specify in a multi-period linear programming model.

4.1.4 Consumption

In contrast to Vandeputte and Baker (1970), a consumption frontier instead of a consumption function was used in the present study. This derived from the earlier review of the Fisher and Hirshleifer approach to consumption-investment choice under certainty.

The specification of the consumption subsystem included nine consumption activities in each year of the model. That is, linear segments approximated a decreasing marginal propensity to consume which traced out the consumption frontier. Basic consumption was forced into the model by an equality constraint. The level of basic consumption was based on the minimum wage for 1975.

Eight luxury consumption activities allowed for additional consumption to proceed at the discretion of the decision maker, i.e., at levels which equated the time preference rate for consumption with the net rate of return from investment opportunities. A disposable income accounting inequality allowed the farmer to undertake consumption of disposable income up to the level set by the consumption frontier. Such an approach incorporated future intended capital outlays on productive assets (such as machinery replacement) into the decision-making process. With an equality constraint on luxury consumption, consumption in any year would proceed independently of required capital expenditure in following years.

In the specification of the consumption subsystem, it was assumed that farmers allocated an amount for consumption at the end of the financial year based on that year's disposable income. Withdrawals for consumption then proceeded on a quarterly basis in the following financial year. An average propensity to consume of 0.525 was used over the estimated disposable income range.

Under this approach, the farm generated its own consumption path through time, according to the Fisher and Hirshleifer framework. In this way consumption behaviour was not constrained to be the same for all farms, but was farm specific, depending on the relationship between consumption and investment. This alternative specification of the consumption activities was compatible with ensuring an optimal solution under the form of objective function assumed for the decision maker.

Detailed specification of these models is contained in Ockwell (1979).

4.2 Wheat models

It was assumed that each of the wheat farms consisted of 668 ha of land at the beginning of the planning period. Of this area, 446 ha were assumed to be sown to wheat, with 160 ha sharefarmed due to an initial constraint on machinery which was available for farming only 286 ha. Each farmer was assumed to be free of debt and to hold similar cash reserves.

Two wheat production activities were included for each year over the planning horizon. First, a 'grow-wheat' activity was specified using land, labour, tractor and machinery. The harvesting of such wheat was accomplished using contractors. Second, a share-farming option was available which absorbed land and incurred one-third of the variable costs of seed, fertiliser and cartage for the land-holder but used the share farmer's labour, machinery and all costs associated with machinery usage. Beef production activities were included under a sideline beef enterprise in the wheat models.

Under the wheat marketing activities, a first advance payment was assumed to contribute cash in the third quarter of each financial year from the sale of harvested wheat. This payment was net of rail freight and other dockages. A later payment for the current year's wheat was made in the following year. The price for wheat was based on the level of the first advance set for the 1975–76 season.

Two marketing activities were included under the beef enterprise. First, vealer calves were sold for an average price of $76 a head. Second, cast-for-age cows were sold for $96 a head. Both prices were assumed to be net of freight, yard dues and sales commission to the stock agent. Since livestock was sold throughout the year, it was assumed that 25 per cent of the livestock marketed were disposed of each quarter. Livestock prices were derived by estimating a 14-year average for prices received by the relevant livestock at the Homebush saleyards, Sydney. All livestock prices were held constant over the planning horizon.

The wheat models included five on-farm investment activities: buying land, buying a tractor(s), buying land cultivation and sowing equipment, buying a bull(s) for the beef enterprise, and buying a cow(s). The option to undertake any of these activities was available only in certain quarters of each year.

In addition to trading bank borrowing activities, two hire-purchase options were included in each year of the wheat models to finance the acquisition of tractor and machinery. In practice, the interaction between hire-purchase commitments and debt commitments to trading banks is realised through a farmer's capacity to repay. The trading banks retain security on their loans through a first mortgage over land, while hire-purchase companies hold the mortgage over the machinery being financed. The specification of hire-purchase activities in the wheat models was based on terms quoted by the Commonwealth Development Bank. In general, the specification of borrowing activities in the wheat, sheep and dairy models was based on the previous research on lender behaviour by Ockwell and Batterham (1980).

4.3 Sheep models

The initial land area for the three managerial situations was assumed to be 207 ha. Again, all were assumed to be free of debt and to hold similar financial reserves. However, the 'superior' manager was assumed to start with a sheep flock comprising 1 168 breeding ewes and producing 6 590 kg of greasy wool. The 'average' manager started with 894 ewes and wool production of 4 709 kg. For the 'inferior' manager, the initial assumption was 600 breeding ewes and 2 985 kg of wool. The differences in flock size and yield of wool were assumed to reflect past management practices.

Two intermediate pasture production activities which related to different grass species were included in the sheep models. Pasture production varied in quality among seasons and was specified in terms of dry matter available per hectare.

The sheep enterprise consisted of two sheep breeding activities for the production of prime lambs and wool: a Merino-based series of activities and a Border Leicester-based series of activities. The breeding component of the two sheep flocks generated livestock valuation units for credit from the pastoral finance companies.

Prime lambs were sold in the second quarter of each financial year following an August lambing. Similarly, cast-for-age ewes were sold from the breeding flocks. Again the prices received for livestock were based on a 14-year average of prices received at the Homebush saleyards.

The price received for wool was based on the floor price for 21 micron wool then in operation under the marketing activities of the Australian Wool Corporation. The price of 128 c/kg (greasy) represented the assumed average price for all wool sold, net of freight and commission.

On-farm investment activities available to the sheep farmer included the options to buy land and to buy livestock. Breeding ewes were available for purchase in the third quarter of each year, in which case they were at the same phase in production as ewes already on the property.

In the sheep models, credit was assumed to be available from a pastoral finance company as well as from a trading bank. Three activities using pastoral financial company credit were specified for each year. Two of these activities used this credit source to purchase Merino and Border-Leicester breeding ewes, respectively. A third activity used this credit to finance operating expenses. All of these activities absorbed livestock valuation units at a ratio of two units for $1 of credit, reflecting a common requirement by pastoral finance companies that borrowings do not exceed 50 per cent of the market value of breeding stock. Further, in accordance with the short-term nature of pastoral finance company loans, these borrowing activities were based on the production cycles of prime lambs and wool. Livestock loans were assumed to be for a term of one year and to be repaid by the sale of prime lambs. These loans absorbed prime lambs for sale during the following year at a rate equal to the amount of the loan plus interest. The net return realised from the sale of prime lambs (i.e., total returns minus freight, commission, yard dues and interest) was recorded for assessing taxable income. In contrast to the livestock loans, the general purpose loan was financed through the sale of wool and was based on a term of six months. The method of repaying the loan and its effect on taxation and disposable income were the same as that for the livestock purchase loans.

4.4 Dairy models

The dairy models were based on dairy farms supplying fresh milk to a metropolitan market under the marketing arrangements of the then Dairy Industry Authority of New South Wales. Quota allocations constrained the amount of milk sold for the fresh milk market. The quotas assumed initially were 199 290 litres for the 'superior' manager (milking herd of 48 cows), 163 916 litres for the 'average' manager (47 cows) and 104 461 litres for the 'inferior' manager (37 cows). These quotas and cow numbers reflected past managerial performance. Each farmer was assumed to own 52 ha of land debt free and to hold similar financial reserves, as in the previous models.

Two pasture production activities specified the amounts of energy generated on a seasonal basis from improved permanent and from temporary pastures. Pasture production was specified in terms of megacalories of energy available per hectare to reflect seasonal variations in pasture quality in lieu of the seasonal demands by milking cows in terms of butter fat content and solids to non-fat ratio. Temporary pasture was sown during the third quarter of the year.

The dairy cow enterprise included three activities: milking cows, replacement dairy calves and replacement dairy heifers. The dairy cow herd activity absorbed cash, labour, digestible energy and milking cows to generate milk, replacement female calves, male calves for sale and culled cows. Coefficients relating to the dairy cow herd accounted for a given proportion of dry cows in the herd as well as the cash costs, labour and energy requirements associated with maintaining dairy bulls. Concentrate feeding of dairy cows was assumed to occur at milking.

Dairy marketing activities included the selling of milk and livestock. Separate milk disposal activities were specified for fresh milk and manufacturing milk on a quarterly basis. Prices specified for milk sales were consistent with prices operating in 1975–76 which represented year one of the dairy models. Four stock disposal activities were included in each year. First, the farmer had the option of breeding replacement heifers for sale as breeding cows. Second, female calves were either retained for the dairy herd or sold as calves. Third, when sold as calves, they were disposed of at the first stock sale along with the sale of male calves. Fourth, there was the sale of culled cows.

Two on-farm investment activities were included in the dairy models: the purchase of an additional farm, and the acquisition of additional dairy cows. The 'buy-farm' activity was specified in terms of a dairy farm with a fresh milk quota attached to it. The 'buy-cow' activity generated a milking cow for the year in which it was purchased.

The only source of credit assumed available for the dairy farmers was trading bank. The specification of credit from this source is given in section 4.1.1.

5. Discussion of Results

The major results of the study are presented in Tables 1 to 3. The effect of varying the amount of trading bank credit from $0 to $100,000 is shown for each industry type and management level. The amount of trading bank credit is the base level available at the beginning of, and throughout, the planning horizon. It can be augmented by additional trading bank credit generated by land purchase, or by other sources of credit (e.g., pastoral finance company or hire-purchase) as appropriate for each model.

Table 1: *Farm Growth in the Wheat Models*

Trading Bank credit (1)	NPV of consumption (2) plus	NPV of terminal assets (3) minus	NPV of terminal debt (4) equals	Value of objective function (5)	Terminal farm size (6)	Year 15 wheat area (7)	Year 15 wheat sharefarm (8)
$	$	$	$	$	ha	ha	ha
			"*Superior*" *Management*				
0	120,531	40,666	1,688	159,509	1 701	791	360
20,000	118,753	47,450	4,468	161,735	2 008	1 242	124
40,000	117,163	50,568	5,539	162,192	2 378	1 248	369
60,000	116,418	54,417	8,453	162,382	2 632	1 284	507
80,000	116,535	57,875	11,879	162,531	2 930	1 285	708
100,000	114,985	62,337	14,665	162,657	3 290	1 295	945
			"*Average*" *Management*				
0	105,358	31,417	443	136,332	1 690	317	818
20,000	102,658	37,531	2,562	137,627	1 986	577	760
40,000	102,540	40,966	5,707	137,799	2 289	559	984
60,000	102,345	44,569	9,068	137,846	2 625	532	1 239
80,000	102,826	47,678	12,623	137,881	2 910	535	1 431
100,000	101,770	52,182	16,042	137,910	3 248	538	1 658
			"*Inferior*" *Management*				
0	91,790	31,468	973	122,285	1 903	..	1 280
20,000	93,103	32,238	2,324	123,017	1 960	..	1 319
40,000	92,769	35,778	5,417	123,130	2 286	..	1 541
60,000	92,606	39,591	9,020	123,177	2 597	..	1 752
80,000	92,034	43,803	12,629	123,208	2 918	..	1 972
100,000	92,034	43,803	12,629	123,208	2 918	..	1 972

Table 2: Farm Growth in the Dairy Models

Trading Bank credit (1)	NPV of consumption (2) plus	NPV of terminal assets (3) minus	NPV of terminal debt (4) equals	Value of objective function (5)	Terminal farm size (6)	Year 15 dairy cows (7)	Year 15 milk production (8)
$	$	$	$	$	ha	No.	L.
			"Superior" Management				
0	135,176	76,770	15,560	196,386	148	182	754 190
20,000	133,055	82,663	18,955	196,763	160	195	809 682
40,000	132,009	86,825	21,709	197,125	168	205	849 649
60,000	131,200	91,102	24,826	197,476	176	214	890 562
80,000	130,636	94,910	27,721	197,825	183	223	927 144
100,000	129,607	99,665	31,107	198,165	192	234	973 882
			"Average" Management				
0	119,888	43,598	5,258	158,228	89	85	290 854
20,000	119,024	47,474	8,055	158,443	97	92	315 970
40,000	118,597	50,662	10,621	158,638	104	99	337 774
60,000	118,197	53,837	13,205	158,829	109	104	354 900
80,000	117,331	57,667	16,015	158,983	112	107	367 458
100,000	116,113	61,885	18,881	159,117	120	115	391 919
			"Inferior" Management				
0	89,806	33,772	3,362	120,216	72	50	141 796
20,000	91,819	34,326	5,564	120,581	73	53	146 055
40,000	91,425	36,706	7,325	120,806	74	54	145 545
60,000	90,541	39,850	9,432	120,959	76	55	149 349
80,000	91,131	42,569	12,640	121,060	79	56	154 554
100,000	90,869	48,176	17,933	121,112	83	61	166 039

Table 3: Farm Growth in the Sheep Models

Trading Bank credit (1)	NPV of consumption (2) plus	NPV of terminal assets (3) minus	NPV of terminal debt (4) equals	Value of objective function (5)	Terminal farm size (6)	Year 15 breeding ewes (7)	Year 15 wool production (8)
$	$	$	$	$	ha	No.	kg
			"Superior" Management				
0	85,547	28,849	954	113,442	255	1 429	8 110
20,000	85,733	30,707	2,599	113,841	273	1 632	9 303
40,000	85,393	31,610	3,160	113,843	298	1 685	9 612
60,000 80,000 100,000	Same results as for trading bank credit of $40,000.						
			"Average" Management				
0	51,908	25,354	. .	77,262	207	895	4 747
20,000	53,571	25,412	1,518	77,465	209	899	4 822
40,000 60,000 80,000 100,000	Same results as for trading bank credit of $20,000.						
			"Inferior" Management				
0	34,575	24,650	. .	59,255	207	691	3 534
20,000	36,652	24,654	1,266	60,040	207	694	3 546
40,000 60,000 80,000 100,000	Same results as for trading bank credit of $20,000.						

The amount of trading bank credit is given in column 1 of each table. The following relationships are used for columns 2 to 5:

net present value of consumption (2) + net present value of terminal assets (3) − net present value of terminal debts (4) = value of objective function (5).

In columns 6 to 8, additional information is provided on the change in the physical size and organisation of the farm.

5.1 The Effect of Trading Bank Credit on the Net Present Value of the Farm Business

The major result of the study was that increases in trading bank credit generated relatively small increases in the net present value of the farm businesses modelled. However, there was a substantial increase in the undiscounted value of assets and debts as the amount of credit available was increased. Farm physical size and production increased markedly for all wheat and dairy models, and for the 'superior' management sheep model.

These results were generally consistent with those of similar and earlier studies in the U.S.A., notably those of Vandeputte (1970), Smith and Baker (1969) and Tsai (1969). These studies emphasised external credit rationing and farm growth.

In the present study, however, the composition of the value of the objective function changed with increases in the amount of credit available. In this case, the net present value of consumption was reduced, whereas the net present value of terminal assets and liabilities both increased. For the most part, when borrowings increased to finance on-farm investment, available cash for consumption decreased as a result of increased commitments to service debt.

There was a general lack of responsiveness in farm growth to increases in credit availability, although there was some variability between industries and levels of farm management. This variation is illustrated in Table 4 where the marginal net present value of the farm business (i.e., net present value of terminal assets and discounted consumption) is shown for each additional $20,000 of trading bank credit available. These 'marginal returns' are net of principal, interest and tax payments. These results indicate steep decreases in 'marginal returns' to credit in the sheep industry models and much less steep decreases in the dairy industry, with the wheat industry being intermediate.

The results presented in Table 4 exhibit the traditional diminishing marginal returns of production economics theory. The 'marginal returns' provide an indication of the efficiency of credit use across the modelled industries and management types for various levels of credit availability.

The most plausible explanation for the relatively small responses of farm business net present value to increasing trading bank credit is that the models accurately reflect the highly constrained real world farming systems. The physical productivity and price ratios that generate net farm income, when combined with the taxation system, mean that after tax returns of investment (excluding capital appreciation) are relatively low. This is consistent with the results provided from BAE surveys of various rural industries (see Kingma 1981, 1982). However, these survey results and other Bureau of Agricultural Economics research (Bond 1979) indicate that a significant component of total investment returns to the rural sector may be derived from capital appreciation. Unfortunately, limited computer funds precluded the option of parameterising rates of capital appreciation to analyse its impact on levels of investment and farm growth through increased access to trading bank credit. As an alternative approximation to the above, the time preference rate was varied and the results from this experiment are discussed in section 5.2.

Table 4: *"Marginal Returns" (Increases in Net Present Value of Farm Business) to Increases in Credit Availability*

Change in Trading Bank Credit ('000)	Increase in net present value of farm business for farm model		
	Wheat	Dairy	Sheep
$	$	$	$
		"Superior" Management	
From 0 to 20	2,226	377	399
20 to 40	457	362	7
40 to 60	190	351	0
60 to 80	149	349	0
80 to 100	126	340	0
		"Average" Management	
From 0 to 20	1,295	215	203
20 to 40	172	195	0
40 to 60	47	191	0
60 to 80	35	154	0
80 to 100	29	134	0
		"Inferior" Management	
From 0 to 20	732	365	785
20 to 40	113	225	0
40 to 60	47	153	0
60 to 80	31	101	0
80 to 100	0	52	0

5.1.1 The effect of reduced borrowing capacity generated by land purchase

The results presented in Tables 1 to 3 were based on the assumption that the purchase of additional land created additional credit (see section 4.1.1). The effect of this assumption was tested by respecifying the models so that only the initial allocation of trading bank credit was assumed to be available at any time over the planning horizon. The dairy models, in particular, were studied using this respecification, since trading bank credit was assumed to be the only source of credit available in these models.

The results provided in Table 5 are those for the 'superior' management dairy farm, and may be compared with the results presented in Table 2. The changes in the value of the objective function and hence, in the increase in net present value of the farm business between the two model specifications, are large relative to those changes generated by different amounts of trading bank credit. A comparable outcome is evident for changes in physical farm size and levels of farm production. This result suggests that farmers can significantly increase the growth of the farm business by using credit to invest in assets that have the capacity to generate additional credit.

Table 5: Farm Growth in the Dairy Model with Alternative Borrowing Specification: "Superior" Management

Trading Bank credit (1)	NPV of con-sumption (2) plus	NPV of terminal assets (3) minus	NPV of terminal debt (4) equals	Value of objective function (5)	Terminal farm size (6)	Year 15 dairy cows (7)	Year 15 milk production (8)
$	$	$	$	$	ha	No.	L.
0	142,665	52,368	..	195,033	101	119	495 237
20,000	141,552	58,221	4,316	195,456	112	137	567 275
40,000	139,985	63,400	7,526	195,859	122	149	620 018
60,000	137,553	69,362	10,662	196,253	132	162	671 430
80,000	136,525	73,924	13,807	196,642	143	174	722 069
100,000	134,940	79,098	17,010	197,028	152	182	756 170

5.2 The Effect of the Time Preference Rate on Farm Growth

All 'superior' management versions of the models were solved for 5 and 15 per cent time preference rates, as well as the 10 per cent rate. The results for the dairy model are reported in Table 6. Results for the other models are essentially similar.

Table 6: The Effect of Alternative Time Preference Rates on Dairy Farm Growth: "Superior" Management

Trading Bank credit (1)	NPV of con-sumption (2) plus	NPV of terminal assets (3) minus	NPV of terminal debt (4) equals	Value of objective function (5)	Terminal farm size (6)	Year 15 dairy cows (7)	Year 15 milk production (8)
$	$	$	$	$	ha	No.	L.
			Five per cent Discount Rate				
0	37,796	268,068	..	305,864	257	311	1 292 455
20,000	32,805	284,598	8,680	308,723	270	321	1 334 515
40,000	28,244	301,125	18,369	311,000	284	338	1 404 949
60,000	27,172	314,326	28,595	312,903	298	359	1 493 019
80,000	27,177	325,263	37,807	314,633	311	377	1 564 490
100,000	28,515	333,067	45,243	316,330	320	388	1 611 719
			Fifteen per cent Discount Rate				
0	114,420	25,555	..	139,976	96	116	483 574
20,000	113,841	28,460	2,148	140,153	107	130	539 230
40,000	113,138	30,906	3,758	140,236	116	141	585 585
60,000	112,798	32,980	5,364	140,414	124	150	624 806
80,000	112,457	35,086	7,002	140,541	132	160	664 646
100,000	112,031	37,287	8,652	140,666	140	170	706 306

As indicated in section 3, the major components of the objective function were consumption, which occurs over the entire planning horizon, and the terminal value of assets and liabilities. Since these components were discounted to derive a net present value, higher time preference rates had the effect of decreasing the 'weighting' given to the terminal value of assets and liabilities relative to that given to consumption. This was particularly so for consumption early in the planning horizon.

On this basis, the results generated by changing the time preference rate are as expected. As the time preference rate is increased (decreased), the value of the objective function is decreased (increased).

6. Conclusion

The effect of trading bank credit on farm growth was studied through a series of multi-period linear programming models. These models attempted to incorporate the results generated by surveys conducted earlier on lender behaviour. Emphasis was focused on trading bank credit since the trading banks represent the main source of institutional credit to agriculture.

The range of management types specified in the farm models generated results which, for the most part, demonstrated the effect of loan repayment capacity on the availability of credit and hence, on farm growth. The better managers realised higher rates of farm growth and enjoyed higher levels of consumption. This suggests that farmers with limited access to credit through poor repayment capacity face problems in ensuring farm viability in the longer term. A greater dependence on internally generated funds to finance on-farm investments means that the interaction between the farm household and the farm firm is critical within the framework of consumption-investment choice.

Time preference rates were seen to affect the rate of farm growth. A lower rate of time preference led to an increase in the rate of farm growth and also to an increase in the proportion of assets in the value of the objective function relative to consumption expenditures. The discount rate also affected the choice of production activities within the farm. Further research is required on the relationship between consumption and investment patterns of farm businesses. Such research may provide an understanding of the interaction between sources and uses of funds for financing particular areas of agricultural investment. The specification of alternative objective functions for the farm would be relevant in analysing the effect of lender policy on the growth and organisation of the agricultural firm.

The main conclusion to be drawn from the results of the farm models is that lender behaviour has the potential for affecting farm growth directly. While only conservative responses were generated in the value of the objective function for each of the models, the composition of that function was influenced by the amount of trading bank credit available to the farm. Investment in land assets generated additional credit for the farm and increased the rate of growth. The availability of credit also affected the path of growth. This was seen in the wheat models through the 'grow-wheat' and 'sharefarming' activities. In the sheep models, increases in the amount of credit available to the farm induced an expansion in the Merino activities at the expense of the Border Leicester activities. The Merino activities generated more wool which was used to secure credit from the pastoral finance company. In contrast, the hire-purchase activities included in the wheat models were generally not taken up to finance the acquisition of machinery.

The increases in farm size generated by the various farm models were found to depend on the level of farm management and the farmer's rate of time preference for consumption. Assumed differences in lender policy towards credit generation by farms were also shown to affect the rate of farm growth.

In the present study, a range of discount rates was applied to establish their effect on farm growth. An understanding of farmers' time preference rates and the consumption behaviour of farm households would be useful in being able to place the results generated by farm models into a better perspective for evaluating policy alternatives. Such research would be relevant in explaining investment, and the financing of investment alternatives.

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