AN ECONOMIC ALTERNATIVE TO CONCESSIONAL FARM INTEREST RATES

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A variable amortization plan is proposed, indexing annual payments made by farm mortgage borrowers. A debt reserve balance also is proposed to stabilize payments received by lenders. Research implied by the proposal is outlined, together with modelling suggestions for investigating effects of the plan on farm income after debt servicing requirements have been met.

Until September 1973, overdrafts from the major trading banks to farmers were subject to concessions of from 0·75 to 1·0 per cent per annum. Concessions remain on loans made with Term Loan Funds and Farm Development Loan Funds, loans from the Commonwealth Development Bank (CDB), and loans to farmers that are administered by State Banks and other state agencies for a variety of special purposes: *e.g.* ex-soldier settlement [20], drought, flood, rural reconstruction, etc. [6, 8]. The amount of concession varies with the type of loan, the special authorization, the administrative costs of the programme and the debt payment performance of the borrower. The annual concessional costs may well run into tens of millions of dollars.

Precise estimates of concessional costs are difficult. The 'equivalent market' costs of loan funds are not easy to establish for several of the programmes. They are made more difficult when the loan programme is not the only programme administered. For example, rural reconstruction programmes have included debt adjustment (with prior creditors). Drought and flood loans sometimes have been associated with relief grants as well. Hence there are knotty problems of cost allocation, in addition to conceptual problems in identifying 'loans'. In addition, lack of precise estimates on demand elasticities make it difficult to estimate the amounts that would have been borrowed in the absence of concessional rates of interest.

Genesis of Loan Concessions

Publicly assisted farm loan programmes finance (1) recoveries from natural or market catastrophes, (2) adjustments to change in technical or market opportunities and (3) accelerated development of properties.

Group one programmes are important in the volatile natural and market environments that characterize much of Australian agriculture. The unpredictable incidence of drought, flood and other natural disasters is well known. So also is the variation of prices received for agricultural products. For many agricultural products, output far exceeds domestic consumption, leaving prices dependent on foreign demand, which is notoriously unstable. Hence receipts from high production *and* high

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prices in one year can plummet in the following year from opposite conditions. Commodity stabilization schemes are appealing though difficult to design without damage to the informational content of markets.

Most financial programmes have been conceived as a 'last ditch' defence against the effects of catastrophic disasters. They have been used in a 'salvage' mode. It would be more appropriate to consider financial programmes as a 'first line' defence. The objective is to make the *financial* environment more stable and predictable, enabling the primary producer to formulate financial management plans to counter risks from his production and marketing environments. An example is the Commonwealth Drought Bond [12]. Survival for many producers depends heavily on the timing of entry or major expansion. Even the most able can be sunk if they start at the onset of a series of years with low prices, output or both. Beginning in years of high output and/or increasing prices, even the weakest of managers can survive, accumulations in good years 'insulating' him against the effects of poor years. Stabilizing the financial environment of producers would reduce the need for market stabilization schemes that adversely affect the operation of markets. It would also reduce the negative economic effects of 'rescue type' credit (or other) programmes used *after* natural or market disasters. The managerially able would be helped to provide their own means for meeting disasters, and would be rewarded for doing so.

Group two programmes are designed to cope with positive environmental events, though the consequences may not be positive for all farmers. Technical change producing scale economies in dairy production creates demands for loans to finance investments for innovating dairy producers and for financial adjustments by those who fail to innovate. Consumer demand and new technology have created a demand for loans to finance broiler production and cattle feedlots. A future example may be oilseed production. The use of public assistance must be based on social payoffs from accelerated adjustments that exceed what can be captured by participants in markets through which the economic rewards flow.

The need for public assistance in Group two programmes is especially suspect. Financial intermediaries are remarkably responsive to opportunities signalled through financial markets, if left with a capacity to respond [16]. The existence of substantial *positive* externalities from adjustment responses may be seriously questioned. The efficiency effects of subsidized interest rates are most debatable [11]. The distributional effects tend to be regressive, for reasons summarized below.

The appeal of Group three programmes is abating with decline in the remainder of natural resources for property development. In any event, loans have been a minor type of public assistance when compared with tax concessions provided for property developers. The social justification rests principally on gains from accelerated property development that exceed those captured by the developers. The costs of liquidity management in property development are large and well known. Hence the appeal of public assistance is understandable. Whether loan (and tax) concessions are the most appropriate forms of public assistance may be open to debate. They can (and have) created distributional inequities in wealth that are an anathema in an egalitarian society. But it is idle to revisit the past other than as a basis for current and future programmes.

Despite proclaimed objectives to the contrary, subsidized interest rates are nearly always regressive, either directly or indirectly. The rich owe more than the poor. Loan funds are diverted to low-interest from high-interest markets, depriving the poor, who depend on the latter. Lowering interest rates adds to capitalized values, favouring relatively more those with more initial wealth. They accelerate growth rates more for large than for small farmers. They tend to destabilize financial markets, imposing liquidity management programmes that are more costly for the poor than for the rich, owing to wider and easier access of the latter to loan supplies. In the absence of interest to allocate loan funds, the rich will be relatively favoured by the use of other allocative criteria. Finally consider the effects of taxes that provide the public resources with which the subsidy is made. Heavy reliance on excise taxes and failure to tax capital gains strongly suggest that the tax system in total may be regressive. Tax policy is beyond the scope of this paper, and the point will not be argued. But it is an important point to establish or refute, when considering the use of public resources to reduce inequalities in income or wealth distributions.

We have ignored inflation as a source of concessional interest rates. A nominal rate of 10 per cent per annum is converted to a *negative* rate, in real terms, by a rate of inflation that exceeds 10 per cent per annum during the maturity of the loan. However, such a concession is in no way unique to farm loans. Indeed, the dearth of facilities to finance farm assets with long term debt may even reduce net concessions to farmers, relative to others, in terms of total interest paid. In terms of both equity and efficiency, a strong case can be made for nominal interest rates to equal at least the rate of inflation. Otherwise borrowing can occur to accelerate a 'run from currency', as borrowers trade debt obligations for commodities, repaying debts with depreciating money. And the use of public sector resources gained through inflation is highly regressive, adding to the regressive effects of concessional interest rates.

Determinants of Financial Market Development

The development of financial markets depends on responses of savers as well as of borrowers. Savers include huge companies as well as small proprietor firms. They include governmental agencies as well as families and individuals. Yet in common, they allocate savings on the basis of relative yield, liquidity and security of financial instruments available to them [3]. In a modern economy such as Australia's, financial instruments are made available principally by financial intermediaries, firms in which claims on and to others dominate among assets and liabilities, and in which economic activities centre upon the purchase, sale and transformation of such claims. The role of the financial intermediary is created by differences between and among borrowers and savers in time, liquidity and risk preferences, at given rates of return. These differences generate the basis for rewards from committing resources to the transformation of debt instruments, in any or all of the three differentiated preferences.

Some savings occur from a difference in time pattern of cash inflow and cash outflow of the saver. For individuals the amounts may be so small that they are left in non-interest demand deposit accounts. However, by increasing rates of interest funds can be attracted to less liquid assets revealing savers willing to exchange liquidity for the higher returns. Some save in anticipation of a future specified consumption or investment outlay. Increasing incomes favour an increase in this kind of saving among individuals, as does an increase in the cost of hire-purchase finance. Comparable savings occur in companies, taking the form of undistributed profits that are budgeted for capital outlays.

Individuals and firms likewise save to provide liquidity with which to meet unpredicted adversity. The cost of liquidity in the form of uncommitted cash is increased by increases in rates earned with financial instruments that serve as near-cash substitutes. Hence increasing interest rates can lower cash reserves, diverting them to the flow of funds available for allocation in loan funds markets. Recent research in the U.S. strongly suggests that raising rates paid on savings deposits might not only increase the volume of loanable funds available to farmers (and others), but also reduce rates of interest paid by farmers [17].

In a more subtle way, stabilizing the financial environment and making it more predictable can lead to similar results. Individuals and firms in a more predictable financial environment can reserve credit by withholding borrowing, substituting the credit reserve for cash. The 'released' cash then can be committed to consumption or production, or to savings in the form of the most attractive available financial instrument. These results will be recognized in firm modelling suggested below for studying farm results from changes in the financial environment.

Finally, some save to accumulate wealth, using the savings as a basis for accelerating expected future earnings, or supplementing reduced earnings expected in future years. This is the most heterogeneous group of savers. The other groups place a heavy emphasis on security of financial instrument, their preferences varying principally in terms of maturity and liquidity. This last group includes those searching for the most speculative of gains as well as those who hold government guaranteed securities. Group three provides the basis for risk-transformations in financial instruments, and involves other financial intermediaries as well as banks.

The value savers ascribe to liquidity is reflected principally in the term structure of interest rates. The nearer the maturity of a debt instrument, other terms equal, the cheaper and easier the conversion of the instrument into cash. The current term structure is revealed in the first column of Table 1. Yields on government securities are 'risk-free' in nominal terms. The only risks to the saver are associated with the value of money in which he is repaid.

Some idea of the risk structure of interest rates is suggested in the rows of Table 1 though the differentiations by risk are minimal in comparison with the range of risks in the market as a whole. In addition, the data in Table 1 do not provide for comparing governments with semi-governments at the same maturities. Yet it is clear from the data of Table 1 that the market is sensitive in terms of interest rate as either maturity or risk increases, and that the differential is substantial even in the minimal comparisons provided in Table 1.

TABLE 1

Yields on Selected Securities, by Term and Risk (% p.a.)

Maturity	Government Securities	Bank Bills	Trade Bills	Semi-government Issues
3 months	7·35[a]	9·60[c]	10·80[c]	
6 months	7·49[b]			
2 years	8·10			
5 years	8·25			
7 years				8·50
10 years	8·35			
15 years				8·70
20 years	8·50			

[a] 91 days
[b] 182 days
[c] 90 days

Source: *The National Times*, 11-16 March 1974.

Concessional Interest Rates and Market Responses

The liquidity of financial instruments farmers offer as they borrow falls far short of liquidity demanded by savers. Moreover, self-liquidating loans lengthen as farmers use increasingly costly and specialized equipment. Inflation too adds to the demand for longer loans, owing to relative increase in the value of fixed assets on farms. Yet inflation reduces interest rates in real terms and makes them less certain as well. Hence the value savers ascribe to liquidity is increased. Shorter maturities and easier conversion become relatively more important properties of debt instruments. Financial intermediaries thus are presented with widening opportunities for rewards from transforming financial instruments in terms of maturities.

But the market response one might expect has been stifled in Australia by public sector policies that have limited maturities on long term loans to periods much shorter than are common elsewhere [7], and by concessions that make interest rates *lower* on long term than on short term farm loans. The details are contained in Table 2 and its footnotes. This anomaly effectively restrains entry of lenders who otherwise might well be expected to provide longer term loans.

Meanwhile the short maturities impose limited and costly liquidity management plans on farm borrowers. They add to the risk problems, already large owing to the production and market environments. Thus they reduce the utility of financial management plans that might be used to manage production and marketing risks. The practice of *ad hoc* repayment holidays, extending loan maturities, etc., in response to borrower distress, does little to help him in financial management. Again, such practices represent the use of credit as a 'salvage' tool rather than as a tool for adjustment and response by the farmer.

Risks associated with farm loans also exceed the low risk tolerances of most savers. (Those with higher tolerances are found in debt markets with higher interest rates or, more likely, in equity markets.) Hence financial instruments offered by farm borrowers must be modified in terms of risk before they are marketable. To some degree this can be accomplished through pooling, based on large numbers. A far more important method in Australia is the addition of the financial strength of the financial intermediary, whose 'endorsement' makes the farmer's

TABLE 2

Interest Rates Paid by Farmers: Australia, 1966-1973, by Type of Loan (% p.a.)

As at 30 June	Type of Farm Loan		
	Overdrafts[a]	Term[b]	Farm Development[b]
1966	7·25	6·72	6·48
1967	7·25	6·86	6·45
1968	7·25	6·97	6·40
1969	7·50	7·13	6·47
1970	8·25	7·67	6·67
1971	8·25[c]	7·69	6·80
1972	7·75	7·85	6·96
1973	7·75	7·95	7·22

[a] On loans outstanding to major trading banks. Maximum rates as at June of each year.
[b] On loans outstanding to Commonwealth Development Bank. The maturities of Term Loans vary from three to eight years; for Farm Development Loans, up to 15 years [7].
[c] Reduced to 7·75 per cent on 4 February 1972.
Source: Reserve Bank of Australia, *Statistical Bulletin*, various issues.

debt instrument marketable. Such dependence gives tremendous advantage to existing institutions relative to any new institutions that might challenge them.

There is also the possibility of using insurance to protect the security-conscious saver against the possibility of inability or unwillingness of borrowers to meet debt commitments. We will make use of this method in a proposal made below to expand long-term lending within the constraint of commercially feasible debt instruments.

A Variable Amortization Proposal

Numerous observers have commented on the need in Australia for more adequate long-term borrowing alternatives [7, 10, 20]. For most farmers the current contractual maximum is about 15 years [7]. Lenders respond that the average length of time a loan remains outstanding is actually considerably less than this. Moreover, it is argued, if the demand for longer loans actually existed there would be a market response [15]. Finally, it is often pointed out that *in fact*, the farmer's debt obligation can be renewed, or extended or otherwise modified in the presence of adversity that reduces his ability to meet a debt commitment.

In the current state of the small market provided by farm borrowers, it is unlikely that a lender could succeed with a longer-term debt instrument at market rates of interest. He would be competing with current loans which, although too short, are at subsidized rates of interest. Indeed, as already noted, they even create an inverse term structure of interest rates on farm loans. But the use of public sector resources to reduce interest rates misses the important need of farm financing.

Long term loans are needed for the liquidity they provide the farmer in developing a financial management plan. Nor is it adequate to argue that in fact he *has* the longer loan owing to informal modifications lenders make in periods of adversity. The farmer's financial environment is, by this behaviour, simply made even less certain. What he needs is greater certainty in his financial environment. The need is especially critical in the highly uncertain production and marketing environments of Australian farmers.

Indeed there is ample reason to argue that even longer term loans *in themselves* fall short of meeting the financing requirements of Australian farmers. Davidson [10] has indicated the increases in percentages of farms that can be made viable by extending loan maturities. While the improvements are impressive, they leave a disquieting percentage that are not viable, many of which would, in all likelihood, be capable of survival and perhaps efficiently adequate performance with loan terms more suitable to their needs.

What seems needed is a longer maturity, to reduce the *average* amortization commitment of the borrower. This would meet the liquidity provisions so necessary to financial management. The annual commitment to the long-term lender would be reduced. The farmer could expect a positive effect on his short-term credit as well. These are important substantive results from the longer maturities.

In addition, the borrower needs to have the average amortization commitment made *variable*, subject to the production and marketing conditions each year [7]. We emphasize that the source of variation should be outside the economic performance of the individual farmer. It would be a mistake to incorporate in a commercially feasible plan an attempt to guarantee the survival of those unable to meet the challenge of the financed farm unit.

At the same time, any commercially feasible plan requires a dependable and preferably even flow of repayments through the loan periods. Otherwise the lender would be a participant in risk-bearing, without equity in the borrower's organization. We propose, in what follows, a plan that makes the farmer's commitment *from current income* dependent on the effects of production and marketing conditions on that income. The plan is centred on the use of a borrower's debt reserve and amortization insurance paid for by the borrower.[1]

In Table 3 we report an index of prices received, PR, by Australian farmers for each of selected commodities from 1967/8 through 1972/3. The table also includes the index of prices paid, PP, by Australian farmers for all production inputs and marketing expenses. In Table 4 we report indexes of production, Q, in the case of wool and wheat sales, and for other commodities with prices indexed as shown in Table 3. We assume the borrower's income to be 52·5 per cent from wool, 8·75 per cent each from sheep and lambs, 25 per cent from cattle and 5 per cent from crops (wheat).[2] These percentages then were used as weights in the following construction of an index of income, $I(Y)$:

$$I(Y) = 0{\cdot}5250 \frac{PR_t \text{ (wool)}}{PP_{t-1}} Q_{t-1} \text{ (wool)}$$

[1] Insured loans have been suggested elsewhere for Australian farmers [7] and are in common use in many countries. However, the insurance costs are not always borne by borrowers as is suggested here.

[2] The percentages are in rough accord with proportions reported for pastoral sheep properties during 1969/70 through 1971/72 [13].

$$+ 0{\cdot}0875 \frac{PR_t \text{ (sheep)}}{PP_{t-1}} Q_t \text{ (sheep)}$$

$$+ 0{\cdot}0875 \frac{PR_t \text{ (lambs)}}{PP_{t-1}} Q_t \text{ (lambs)}$$

$$+ 0{\cdot}25 \frac{PR_t \text{ (cattle)}}{PP_{t-1}} Q_t \text{ (cattle)}$$

$$+ 0{\cdot}05 \frac{PR_t \text{ (wheat)}}{PP_{t-1}} Q_{t-1} \text{ (wheat)}$$

The result is a series of income indexes for the years 1968/9 through 1972/3. This series is shown in Column 1 of Table 5 as a simulation of income indexes for the first five years of a debt period. The values in this series will be used in determining the size of annual payment required of the borrower to amortize a debt. The remaining columns of Table 5 show the effect of the index in a specific example.

Consider a loan of $70,000 to finance $100,000 of assets to be used to produce income in the proportions indicated in the above enterprises.

TABLE 3

Indexes of Prices Received and Paid by Australian Farmers, 1967/68–1972/73: Base Period, 1960/61–1962/63

Year	Wool	Sheep	Lambs	Cattle	Wheat	Prices Paid
1967/68	91	114	123	139	105	118
1968/69	98	107	100	140	102	120
1969/70	83	109	104	143	93	121
1970/71	65	85	93	149	97	126
1971/72	82	83	91	144	100	133
1972/73[a]	172	153	144	182	105	143

[a] Average of first three quarters, 1972/73.
Sources: B.A.E., *Quarterly Review of Agricultural Economics*, various issues, 1968-1973; and W. Hoogvleit, 'The Australian Sheep Industry Survey 1971-72', *Quarterly Review of Agricultural Economics*, 26: 3 (July 1973), pp. 171-185.

TABLE 4

Indexes of Output of Australian Agriculture, 1967/68 through 1972/73: Base Period, 1965/66–1972/73

Year	Wool Output	Slaughters of Sheep	Slaughters of Lambs	Cattle on Sheep Properties[a]	Wheat Output
1967/68	96	100	87	69	80
1968/69	106	82	103	86	156
1969/70	110	100	110	102	112
1970/71	106	106	120	124	83
1971/72	107	137	124	138	90
1972/73	90	103	99	156	70

[a] W. Hoogvliet, *op. cit.*
Source: B.A.E., *Quarterly Review of Agricultural Economics*, various issues.

TABLE 5

Simulated Disposable Income, Debt Service Commitment and Amount to Debt Service Reserve

Year of Debt	Income Index	Disposable Income[a]	For Debt Service	Amount to Reserve[c]
1	85	6,120	6,120[b]	0
2	91	6,552	6,552[b]	0
3	88	6,336	6,336[b]	0
4	95	6,840	6,625	215
5	149	10,728	6,625	4,103

[a] 7,200 × Income index/100.
[b] Disposable Income < 6,625 (the amortization).
[c] Column 2 less Column 3.

We assume the annual average rate of return, before consumption and taxes, to be 12 per cent: $12,000. Let consumption and taxes absorb $4,800, leaving a balance of $7,200 in disposable income. If the loan bears an annual interest rate of 9 per cent, it might be written with a maturity of 35 years to allow for complete amortization from disposable income. The annual amortization would be $6,625.

The proposed debt service arrangement requires that the lender receive the full $6,625 each year, regardless of the borrower's income status. The payment is to come from (1) the borrower's disposable income, insofar as it provides enough for the amortization, (2) a borrower's 'debt reserve balance', insofar as is necessary to make up for any deficit in disposable income to reach the amortization commitment and (3) an insurance indemnity, if required to supplement the payments from disposable income and the debt reserve balance.

The second column of Table 5 reports disposable income: $7,200, adjusted by the index values in the first column. The third column reflects the payments required from the borrower: $6,625, adjusted by the index values in the first column, for the first 5 years of the debt period, assuming the years repeat the 5-year pattern of 1968/69 through 1972/73. The effects on the borrower's contributions to the debt reserve are shown in the last column of Table 5. In years of deficit in disposable income, no payments are made into the reserve. In years of 'surplus' disposable income, an amount in excess of the amortization amount is required to be paid into the reserve. In turn the lender (or whoever holds the debt reserve) is required to pay the borrower an interest payment on the reserve balance, at the rate the borrower pays on his loan.

In Table 6, we show the amount paid to the lender from the sources already referred to. The occasional failure of current income plus debt reserve balance to meet the amortization requirement suggests the necessity of insurance. An inspection of results simulated from the 5-year period preceding the loan (*e.g.* 1967/68–1972/73) suggests insurance in the amount of $1,500, at a cost of $375 per year.[3] A more

[3] Actuarial cost plus 25 per cent of actuarial cost, to pay for administration of the insurance program, less an allowance for earnings from investments made with insurance premiums.

TABLE 6

Sources of Amortization ($6,625 each year)

Year of Debt	Current Income[a]	Debt Reserve	Insurance
	$	$	$
1	6,120	0	505
2	6,552	0	73
3	6,336	0	289
4	6,625	0	0
5	6,625	0	0
6	6,120	505	0
7	6,552	73	0
8	6,336	289	0
9	6,625	0	0
10	6,625	0	0
11	6,120	505	0
12	6,552	73	0
13	6,336	289	0
14	6,625	0	0
15	6,625	0	0
..	..	..	..

[a] Column 3, Table 5. (Repeated 5-year series.)

defensible actuarial process would be required to make the debt service plan sound for an insurer and acceptable to the borrower. The assumed cost of insurance is about 0·53 per cent per annum of the beginning loan balance. Under assumptions of this example, $1,500 of insurance proves ample in the evolution of the loan. Even if one ignores earnings from investments made with premiums, the cumulative deficit disappears in the second year of debt. One might consider phasing out the requirement that the borrower provide amortization insurance, as the size of his debt reserve balance grows.

The net cost to the borrower of the debt reserve plan is the amount of interest he pays each year, plus the cost of the insurance, less any returns he receives from his debt reserve balance. The returns are shown in Table 7. The net gains or losses from the debt reserve plan are shown in the first column of Table 8. The cost of interest on the actual loan is shared between the borrower and the insurer, insofar as the insurance indemnity is actually drawn upon. In any event the *total cash outflow* can be found by adding the debt service payment of Table 5 (Column 3) and the net cost of the debt service plan, as shown in the first column of Table 8. Subtracting this net figure from estimated disposable income, we find the income available after debt. This figure, in Column 3 of Table 8, is compared in Table 8 with the amount that would be available to the borrower after servicing a conventional debt of $70,000, amortized in 35 years at 9 per cent per annum. (See the last column of Table 8.)

The effects of the debt reserve plan would become even more marked as the period of the loan progresses beyond 15 years. The cumulative debt reserve balance grows, as do returns to the borrower from the balance. Indeed, the debt reserve balance eventually will equal the outstanding balance on the loan itself as the debt balance declines. Hence the debt reserve balance can then be applied by the borrower to liquidate the remaining debt. Paradoxically, writing the loan for 35 years has the effect, in fact, of reducing the *actual* length that might

TABLE 7

Borrower's Return from Debt Reserve Balance

Year of Debt	Payment to Debt Reserve[a]	Payment from Debt Reserve[b]	Debt Reserve Balance	Return from Debt Reserve Balance[c]
	$	$	$	$
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	215	0	215	0
5	4,103	0	4,318	19
6	0	505	3,813	389
7	0	73	3,740	343
8	0	289	3,451	337
9	215	0	3,666	311
10	4,103	0	7,769	330
11	0	505	7,264	699
12	0	73	7,191	654
13	0	289	6,902	647
14	215	0	7,117	621
15	4,103	0	11,220	641
..	..	..	..	..

[a] Column 4, Table 5 (repeated in 5-year series).
[b] Column 2, Table 6.
[c] 9 per cent of the previous year's balance.

TABLE 8

Cash Flow with Debt Reserve Plan and Conventional Amortization Plan

Year of Debt	Net gain or Loss from Debt Reserve[a]	Debt Service Payment[b]	Cash Flow after Debt Service	
			Debt Reserve Plan[c]	Conventional[d]
	$	$	$	$
1	—375	6,120	— 375	— 505
2	—375	6,552	— 375	— 73
3	—375	6,336	— 375	— 289
4	—375	6,625	— 160	+ 215
5	—356	6,625	+3,747	+4,103
6	+ 14	6,120	+ 14	— 505
7	— 32	6,552	— 32	— 73
8	— 38	6,336	— 38	— 289
9	— 64	6,625	+ 151	+ 215
10	— 45	6,625	+4,058	+4,103
11	+324	6,120	+ 324	— 505
12	+279	6,552	+ 279	— 73
13	+272	6,336	+ 272	— 289
14	+246	6,625	+ 461	+ 215
15	+266	6,625	+4,369	+4,103
..	..	..	..	..

[a] Column 4, Table 7, minus cost of insurance ($375 = actuarial cost of $1,500 plus allowance for insurance administration).
[b] Column 3, Table 5 (repeated in 5-year series).
[c] Column 2, Table 5 (repeated in 5-year series) less Column 2, Table 8, plus Column 1, Table 8.
[d] Column 2, Table 5, less $6,625.

be expected for the loan. Meanwhile, the lender is assured a constant amortization each year, varied only by the commitment to pay back to the borrower an interest payment at the mortgage rate the borrower pays the lender.

The above gains to the borrower from the debt reserve plan are likely to be considerably understated. They ignore the gains from a more stable financial environment the plan provides. In turn, the borrower is able to pursue production and marketing plans denied him under the more binding constraints of a conventional amortization plan. Also, the borrower may well expect a more adequate response from bankers and other non-real estate lenders, given a more stable expected cash flow, and a more secure basis for meeting commitments on the long term debt. Hence the costs of liquidity management are reduced. Research in the U.S. [18] suggests that non-real estate lenders are more responsive to annual debt-service commitments than they are to the level of outstanding real estate debt. It is plausible to assume their response to an annual debt service commitment to be especially negative in the presence of highly variable annual income.

Discussion

The arithmetic of the specific example need not be taken as definitive in describing the essential ideas in the debt reserve plan. For example, one might regress income on price and weather variables and use the standard error of estimate as a basis for indexing income. Clearly such a procedure would rest on the availability of suitable base studies, defined in type and area. Moreover, as technical changes occur, the base studies would require 'updating', introducing a problem in modifying the income index in terms suitable to both borrower and lender. If price and output indexes are used, there is no reason for resting the plan on five year sequences, whether average, best, worst, or the actual past (as in the above example). It might be appropriate to establish the terms of reference by examining seven-year, ten-year, or other sequences.

Even given the above numerical example of income indexing, added variations should be studied. There is little reason for suspecting non-random weather conditions for most Australian farms. Hence the five-year sequence generates 5! patterns of income variations. A simple extension would be to examine the 'best' and 'worst' sequences in terms of the cumulative debt reserve balance. In turn, the dependence on insurance would be varied. A conservative plan might be based on the worst of sequences revealed by the past.

The requirement that the borrower be paid interest on his debt reserve at the rate he pays on the farm mortgage is somewhat arbitrary. Alternatives could be explored for their implications to lender and borrower. As already mentioned, the amount and cost of amortization insurance would also need to be studied further for a defensible actuarial basis. However, if the general plan is mutually advantageous to all participants, the operational details can be worked out. An appendix is added to suggest a method for estimating effects of the plan on the farm borrower. Comparable research is needed to estimate effects on the lender.

APPENDIX

Suggested Research

Adoption of a variable amortization plan would affect financial markets and the economic organization of farms. The modification in total flow of loan funds may be small enough that market effects can safely be disregarded. The principal problem with respect to the market is to design an instrument and an insurance plan acceptable to market participants, which, in combination, produce loan terms significantly better for farmers than now exist—or which would now exist in the absence of concessional interest rates. Recent evidence [21] suggests that Australian farmers respond less to interest rates than to non-interest terms of loans. The essential question for farmers is the joint effect of higher interest rates and *predictably* longer maturities. In Tables 9 and 10 we indicate with row and column identifications, respectively, a linear programming model with the necessary properties for studying this question.[4]

TABLE 9

Row specifications for a linear programming model for studying farm effects of change in financial environment

Row	Description		Constraint Rel.	Constraint Lev.	Row	Description		Constraint Rel.	Constraint Lev.
1	Grazing land I		L	b	33		3	L	b
2	Grazing land II		L	b	34		4	L	b
3	Cropland I		L	b	35	Term loan (TLC)[a]		L	b
4	Cropland II		L	b	36	FDC (FDLC)[b]		L	b
5	Sheep inventory		E	b	37	LAS credit (LASC)[c]		L	b
6	Cattle inventory		E	b	38	CDB credit (CDBC)[d]		L	b
7	Wool		E	0	39	Overdraft debt	1	E	0
8	Fodder reserve		E	b	40		2	E	0
9	Machinery		L	b	41		3	E	0
10	Buildings		L	b	42		4	E	0
11	Resident labour	1	L	b	43	Pastoral debt	1	E	0
12		2	L	b	44		2	E	0
13		3	L	b	45		3	E	0
14		4	L	b	46		4	E	0
15	Hired labour I	1	L	b	47	TL debt		E	0
16		2	L	b	48	FDL debt		E	0
17		3	L	b	49	LAS debt		E	0
18		4	L	b	50	CDB debt		E	0
19	Hired labour II	1	L	b	51	Cash account	1	E	0
20		2	L	b	52		2	E	0
21		3	L	b	53		3	E	0
22		4	L	b	54		4	E	0
23	Cash	1	E	b	55	Cash 1 reserve	20%	E	0
24		2	E	0	56		40	E	0
25		3	E	0	57		60	E	0
26		4	E	0	58		80	E	0
27	Overdraft (OC)	1	L	b	59	Cash 2 Reserve	20%	E	0
28		2	L	b	60		40	E	0
29		3	L	b	61		60	E	0
30		4	L	b	62		80	E	0
31	Pastoral Credit (PC)	1	L	b	63	Cash 3 reserve	20%	E	0
32		2	L	b	64		40	E	0

[4] Some may find it useful to refer to an earlier article [2] that outlines some of the basic elements of financial components in firm models. However, the model suggested below is much more complete in representing liquidity management options and requirements.

TABLE 9 (continued)

Row	Description		Constraint Rel.	Constraint Lev.	Row	Description		Constraint Rel.	Constraint Lev.
65		60	E	0	102		80	E	0
66		80	E	0	103	PC 2 reserve	20%	E	0
67	Cash 4 reserve	20%	E	0	104		40	E	0
68		40	E	0	105		60	E	0
69		60	E	0	106		80	E	0
70		80	E	0	107	PC 3 reserve	20%	E	0
71	OC account	1	E	0	108		40	E	0
72		2	E	0	109		60	E	0
73		3	E	0	110		80	E	0
74		4	E	0	111	PC 4 reserve	20%	E	0
75	PC account	1	E	0	112		40	E	0
76		2	E	0	113		60	E	0
77		3	E	0	114		80	E	0
78		4	E	0	115	TLC reserve	20%	E	0
79	TLC account		E	0	116		40	E	0
80	FDLC account		E	0	117		60	E	0
81	LASC account		E	0	118		80	E	0
82	CDBC account		E	0	119	FDLC reserve	20%	E	0
83	OC 1 reserve	20%	E	0	120		40	E	0
84		40	E	0	121		60	E	0
85		60	E	0	122		80	E	0
86		80	E	0	123	LASC reserve	20%	E	0
87	OC 2 reserve	20%	E	0	124		40	E	0
88		40	E	0	125		60	E	0
89		60	E	0	126		80	E	0
90		80	E	0	127	CDBC reserve	20%	E	0
91	OC 3 reserve	20%	E	0	128		40	E	0
92		40	E	0	129		60	E	0
93		60	E	0	130		80	E	0
94		80	E	0	131	Total liquidity	1	L	b
95	OC 4 reserve	20%	E	0	132		2	L	b
96		40	E	0	133		3	L	b
97		60	E	0	134		4	L	b
98		80	E	0	135	A requirement		E	A
99	PC 1 reserve	20%	E	0	136	DR balance		E	0
100		40	E	0	137	DR maximum		E	A
101		60	E	0					

[a] Term Loan Credit.
[b] Farm Development Loan Credit.
[c] Life Assurance Society Credit.
[d] Commonwealth Development Bank Credit.

The model is designed for a farm producing crops, wool and cattle. The first two rows of Table 9 identify grazing land divided into two types. The third and fourth rows do the same for crop land. The differentiations can be quality, spatial or any other that would be useful for the type of farm in question. Rows 5 through 8 identify inventories that are supplied by production activities (see Columns 5 and 6 in Table 10), and from which sales are made (see Columns 7 through 12 in Table 10).

Rows 9 and 10 provide capacity constraints in terms of machinery and buildings, respectively. Rows 11 through 22 constrain the model in terms of labour, seasonally specified. (The arabic numbers, 1-4, at the right of row descriptions, identify seasons: four per year.) Rows 15 through 22 specify limits in two qualities of labour that can be hired

TABLE 10

Activities for a linear programming model for studying farm effects of change in financial environment

Column	Description		Column	Description	
1	Acquire grazing land		60	Carry over PD 3	
2	Acquire crop land		61	Repay PD 4	4
3	Produce, sell wheat		62	Carry over PD 4	
4	Produce, sell barley		63	Amortize TLD	
5	**Produce wool**		64	Amortize FDLD	
6	Produce cattle		65	Amortize LASD	
7	Sell wool	1	66	Amortize CDBD	
8		2	67	Reserve cash 1	0%
9		3	68		20
10		4	69		40
11	Sell cattle I		70		60
12	Sell cattle II		71		80
13	Hire labour I	1	72	Reserve cash 2	0%
14		2	73		20
15		3	74		40
16		4	75		60
17	Hire labour II	1	76		80
18		2	77	Reserve cash 3	0%
19		3	78		20
20		4	79		40
21	Transfer cash	12	80		60
22		23	81		80
23		24	82	Reserve cash 4	0%
24		4Z	83		20
25	Borrow overdraft	1	84		40
26		2	85		60
27		3	86		80
28		4	87	Value cash 1 reserve	20%
29	Borrow pastoral	1	88		40
30		2	89		60
31		3	90		80
32		4	91		100
33	Borrow TL		92	Value cash 2 reserve	20%
34	Borrow FDL		93		40
35	Borrow LAS		94		60
36	Borrow CDB		95		80
37	Repay OD1	1	96		100
38		2	97	Value cash 3 reserve	20%
39		3	98		40
40		4	99		60
41	Repay OD2	2	100		80
42		3	101		100
43		4	102	Value cash 4 reserve	20%
44	Carry over OD2		103		40
45	Repay OD3	3	104		60
46		4	105		80
47	Carry over OD3		106		100
48	Repay OD4		107	Reserve OC 1	0%
49	Carry over OD4		108		20
50	Repay PD 1	1	109		40
51		2	110		60
52		3	111		80
53		4	112	Reserve OC 2	0%
54	Repay PD 2	2	113		20
55		3	114		40
56		4	115		60
57	Carry over PD 2	4	116		80
58	Repay PD 3	3	117	Reserve OC 3	0%
59		4	118		20

TABLE 10 (continued)

Column	Description		Column	Description	
119		40	175		80
120		60	176		100
121		80	177	Value PC 3 reserve	20%
122	Reserve OC 4	0%	178		40
123		20	179		60
124		40	180		80
125		60	181		100
126		80	182	Value PC 4 reserve	20%
127	Value OC 1 reserve	20%	183		40
128		40	184		60
129		60	185		80
130		80	186		100
131		100	187	Reserve TLC	0%
132	Value OC 2 reserve	20%	188		20
133		40	189		40
134		60	190		60
135		80	191		80
136		100	192	Value TLC reserve	20%
137	Value OC 3 reserve	20%	193		40
138		40	194		60
139		60	195		80
140		80	196		100
141		100	197	Reserve FDL credit	0%
142	Value OC 4 reserve	20%	198		20
143		40	199		40
144		60	200		60
145		80	201		80
146		100	202	Value FDLC reserve	20%
147	Reserve PC 1	0%	203		40
148		20	204		60
149		40	205		80
150		60	206		100
151		80	207	Reserve LASC credit	0%
152	Reserve PC 2	0%	208		20
153		20	209		40
154		40	210		60
155		60	211		80
156		80	212	Value LASC reserve	20%
157	Reserve PC 3	0%	213		40
158		20	214		60
159		40	215		80
160		60	216		100
161		80	217	Reserve CDB credit	0%
162	Reserve PC 4	0%	218		20
163		20	219		40
164		40	220		60
165		60	221		80
166		80	222	Value CDBC reserve	20%
167	Value PC 1 reserve	20%	223		40
168		40	224		60
169		60	225		80
170		80	226		100
171		100	227	Index income	
172	Value PC 2 reserve	20%	228	Add to DR balance	
173		40	229	Returns from DRB	
174		60			

(see Columns 13 through 20 in Table 10). Columns 1 and 2 of Table 10 provide for adding or developing grazing and crop land, respectively. No provision is made for adding machine or building capacity, though it would not be hard to do so.

All the remaining rows relate to financial management. Row 23 specifies the amount of cash with which the farmer starts the year. Rows 27-38 specify credit limits that constrain the amount the modelled farm can use for borrowing (see Columns 25-36 in Table 10) or in reserve (see Columns 107-126, 147-166, 187-191, 197-201, 207-211, and 217-221 in Table 10).

Both cash and credit limits are subject to modification, respectively, by activities that produce or use cash and that create or absorb credit. Any of the first 20 activities of Table 10 can influence cash, as reflected by coefficients in relevant row, column cells. Cash also can be supplied by borrowing and used for debt payments (see Columns 37-66 in Table 10). Finally, cash is transferred between seasons, as shown by Columns 21-23. Any surplus at the end of the last season is transferred to the objective function, Z, as indicated by column 24.

The objective function is not shown in Table 9. It contains, in fact, only a coefficient, 1·00, in Column 24, value coefficients for cash and credit in reserve, and coefficients in column vectors that carry unpaid debt into the next year. The cash reserves are valued in Column 87-106. Credit reserves are valued in Columns 127-146, 167-186, 192-196, 202-206, 212-216, and 222-226. In all cases, the value of reserves declines with increased percentages reserved. This accords with the plausible assumption that the smaller (larger) the reserve of liquidity the higher (lower) the value of an increment to the reserve.

Finally, the whole model is constrained by four seasonal 'total' liquidity requirements: Rows 131-134. These requirements can be satisfied by cash *or* credit (or any other source of liquidity that might have been specified) and clearly will draw upon cash or the various types of credit according to (1) values that appear in the objective function and (2) contributions made to profitability of the production and marketing organization. The latter are reflected by coefficients in cash rows.

The alternatives and requirements in debt management are described in Columns 37-66 and Rows 39-50, respectively. Debt is created by borrowing, assumed to occur on the first day of the season. Repayment is assumed to occur on the last day of the season. Interest will be reflected by the size of coefficients in cash rows in the debt repaying activities. Overdraft and pastoral finance company debt are assumed to be payable within one year. The activities (Columns 37-62) provide for repayment in any quarter after borrowing, or, for loans after quarter one, for carrying an unpaid balance forward at the end of the year. Hence Columns 44, 47, 49, 57, 60 and 62 will contain negative coefficients in Z.

The remaining types of credit are not subject to seasonal specification. Borrowing is assumed to occur on the first day of the year. The amortization payment can be specified in the cash row consistent with the debt contract, or in Z. In any event the coefficient in Z will reflect the unpaid balance of debt, after payment of the amortization requirement.

To reflect the debt reserve plan requires adding three more rows and three more columns. Row 135, in Table 9, is required to register any change in the payment required of the borrower with respect to the amortization specification as given in the loan contract ($6,625, in the above example). Any change will be reflected in the coefficient in Row 135, Column 227, where Column 227 is the vector that registers the index consistent with prices received and paid, as shown elsewhere in the model.

Any *excess* above the loan amortization is required to be transferred to a debt reserve balance (Row 136) by an activity that also modifies credit otherwise available to the borrower (Column 228). 'R . . . Credit' in Table 11 is meant to represent all credit rows indicated in Table 9. Finally, an activity is required (Column 229) to produce returns to the borrower from the debt reserve balance. It is subject to a maximum, generated by a negative coefficient in Column 227, to prohibit the transfer of *all* excess income to the debt reserve balance. Any shortfalls of disposable income will activate the use of insurance indemnities. But this need not be included in the model, inasmuch as the insurance premium already will have been shown in a cash row. The matrix detail for the added rows and columns is given in Table 11.

To show how cash and credit are subject to use and reservation, we provide matrix detail in Tables 12 and 13, respectively. In the case of cash, we include seasonal specifications, as suggested in Tables 9 and 10, so as to show the cash transfer vectors. Otherwise we ignore seasonal or type (as with credit) specifications. Instead, we show how cash in *any* season, or credit in any season *or* from any lender would be specified to make it possible to reflect behavioural responses of borrowers to their financial environment.

Thus in Table 12, the right-hand side includes the relevant cash constraints, as given in Tables 9 and 10. We have added the related components of the objective function, Z (the relation to be maximized). The last four activities provide for inter-season cash flows and for the transfer of any surplus into Z. The first five vectors allow for cash available in Season 1 to be allocated (in intervals of 20 per cent) between the cash account, from which cash is available for use, and cash reserve, in which it is valued as shown in the next five vectors. The values of $c_1 \ldots c_5$ must be estimated [4]. It is presumed that the values will decline, from c_1 through c_5, reflecting diminishing values ascribed to successively higher reservation levels for cash in reserve.

The matrix specification for credit management (as distinct from debt management, as described above) is provided in Table 13. The first five

TABLE 11

Matrix Specification for Debt Reserve Plan in the Amortization of Long-Term Debt

Row	Description	(227) Index Income	(228) Increase DRB	(229) Returns from DRB	Constraint Rel.	Constraint Lev.
135	Amortization requirement	—a	1		E	A
136	Debt reserve balance (DRB)		—1	1	E	O
137	Debt reserve maximum	—a	1		E	A
R . . . Credit			—a		E	O
Objective Z				1 + I	E	M

TABLE 12

Matrix Specifications for Cash Management

Row Description		Reserve Cash 1					Value Cash 1 Reserve					Transfer Cash				Constraint	
		0	20	40	60	80	20	40	60	80	100	12	23	34	4Z	Rel.	Lev.
Cash	1	1	1	1	1	1						1				E	b
	2											−1	1			E	0
	3												−1	1		E	0
	4													−1	1	E	0
Cash account	1	−1	−·8	−·6	−·4	−·2										E	0
Cash reserve	20%		−·2				1									E	0
	40			−·4				1								E	0
	60				−·6				1							E	0
	80					−·8				1						E	0
LR requirement							1	1	1	1	1					L	b
	Z						c_1	c_2	c_3	c_4	c_5				1	E	M

c

columns distribute credit between the credit account, whence it is drawn upon by borrowing activities (not shown in Table 13), and credit reserve, where it is valued as shown in the following five activities. Credit, like cash, can satisfy the total liquidity reserve requirement, as shown in the 'LR requirement' row of Table 13. The values, c_1 through c_5, are presumed to decline, since the value of an increment to credit reserve doubtless is less, the higher the percentage of credit already reserved.

When interpreting solutions of models that include cash and credit management vectors, such as those illustrated in Tables 12 and 13, it is necessary to subtract from Z the contributions of the reserves-valuing vectors. Otherwise, it would not be possible to compare Z with any accounting concept of income now current. But this is a simple task, since the computer output clearly indicates the activation level of each variable in Z.

Finally we note that the model is stated in terms of 'before-tax' income. There may be good reasons for studying the effects of the variable amortization plan free of any associated tax effects. However, it is relatively simple to add vectors to allow for tax accounting [19]. It is necessary only that rows be added to accumulate tax obligations from the activities included in the model, and to add tax-paying vectors that accord with the relevant tax laws.

The model used to estimate farm-level effects of the debt reserve plan need not to be confined to the suggested one-year linear programming model. It can be argued that one-year linear programming models do have useful and relevant properties. They can be solved with efficient algorithms, yielding solutions that are rich in operational implications. They also avoid difficult conceptual problems of horizon specifications [5]. The deterministic assumptions, so frequently criticized, are modified by the liberal use of liquidity management vectors. The vectors are capable of reflecting, in relevant parameters, behavioural responses to an uncertain environment. Moreover, since credit supplies a significant source of liquidity, this mode of response behaviour may be peculiarly appropriate to the study of response to change in the financial environment.

However, recursive programming [9] and simulation [1] represent

TABLE 13

Matrix Specification for Credit Management

Row Description	Reserve Credit					Value Credit Reserve					Constraint	
	0	20	40	60	80	20	40	60	80	100	Rel.	Lev.
Credit	1	1	1	1	1						E	b
Credit account	−1	−·8	−·6	−·4	−·2						E	0
Credit reserve												
20%		−·2				1					E	0
40			−·4				1				E	0
60				−·6				1			E	0
80					−·8				1		E	0
LR requirement						1	1	1	1	1	E	0
Z						c_1	c_2	c_3	c_4	c_5	E	M

alternative or perhaps complementary [14] methods of modelling that might be used. Specifically, Kingma [14] has developed a modelling procedure with many features that make it appealing in estimating the effects of change in terms of long term lending. *As currently developed,* his model may be deficient in linking the firm with its financial environment. But the deficiencies could be remedied without, it appears, damaging other desirable properties of the model. The principal advantages gained would be a multi-year representation of the firm and a basis for reflecting stochastic processes in the production and marketing environment of the firm.

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