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A FARM GROWTH MODEL FOR POLICY ANALYSIS IN AN EXTENSIVE PASTORAL PRODUCTION SYSTEM

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The development of a simulation model of an extensive pastoral farming system to assist analysts in their assessment of government policy measures is described. The model was designed to simulate, over a number of years, the physical and financial operation of a sheep and beef production system typically found in the North Island hill country of New Zealand. By manipulating model parameters and data related to prices, costs, taxation and credit, a range of policies can be represented and their effects simulated. The model is used to undertake an *ex post* analysis of the farm-level impact of the supplementary minimum price scheme in New Zealand and to project farm performance following the abolition of the scheme. Consideration is given to the use of the model to represent sheep and beef production systems elsewhere.

Extensive pastoral production systems are widespread throughout the world and there has been a significant research effort over recent years aimed at improving animal production and management standards in these systems. An important contribution to this effort has been made through the development of bio-economic simulation models which facilitate the evaluation of alternative management strategies under a range of environmental and economic conditions.

A number of such models which specifically relate to extensive beef production systems were reviewed by Chudleigh and Cezar (1982) and include models applicable to the Pampas area of Argentina (Brava 1970; Fujita 1974), the Cerrado region of central Brazil (Monteiro, Gardner and Chudleigh 1980), semi-arid areas of Kenya (Simpson, Gunawardena and Wynne 1977) and Botswana (Anderson and Trail 1978), and pastoral areas in Australia (Reeves, Sekavs, Abel and Cottingham 1974; Beck, Harrison and Johnston 1982).

In contrast to this development of 'management' models for extensive pastoral systems, relatively little work appears to have been done to facilitate the assessment of the effect of government policy and other external socio-economic factors in such systems. Methodology to achieve this objective is available and could be expected to make a useful contribution to the process of policy planning and evaluation (Baum and Schertz 1983).

This paper is concerned with the development and application of a farm-level policy model of an extensive pastoral farming system. Within the context of policy evaluation models, such farm-level models are justified on the grounds that they can be used to simulate, explicitly and in detail, the physical and financial operation of farming systems. In this way they indicate farm-level response to changes in various aspects of the physical, financial and socio-economic environment. Some of

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these aspects, such as input and output price levels, price stability, tax rates, and credit conditions may be influenced by government policy. At this level of modelling and analysis, understanding can be gained of the actual process by which a policy influences farmers and farming systems. Analysis at the farm level also allows an understanding of how different farm situations and farmer circumstances can affect the nature and extent of policy response.

While the model described here was developed for a New Zealand pastoral production system (based on New Zealand's North Island hill country) similar extensive pastoral systems exist in many parts of the world and a similar model could well be of value for these areas.

Operationally, a farm growth model was required which was capable of representing the various physical, financial and behavioural components of the farming system in a dynamic and stochastic framework. Sufficient flexibility was required to allow a range of policy instruments, and their impact on various components of the farming operation, to be represented. An appropriate methodology in this context involves the use of simulation-based models. Examples include pure simulation models (Patrick and Eisgruber 1968; Charlton 1972), models combining simulation and single-period linear programming components (recursive programming) (Kingma 1973; Kingma and Kerridge 1977) and combined multiperiod linear programming and simulation (Chien and Bradford 1976). Such models, often referred to as farm growth models, can represent a dynamic and stochastic farming system involving divisible and indivisible factors, and non-linear production and financial relationships. They can also provide the necessary flexibility to allow a range of behavioural decision rules to be incorporated into the dynamic and stochastic structure (Dent and Anderson 1971; Anderson 1974; Dent and Blackie 1979).

A pure simulation approach was adopted here. The procedures used in the analysis of the system and the development and testing of the model are described in following sections. In the second half of the paper the use of the model to assess the impact of the supplementary minimum price scheme is described.

System Analysis

A detailed analysis of the pastoral production system was conducted to provide the foundation for model development. The full results of this analysis are described elsewhere (Beck 1984; Beck and Dent 1984). In summary, four main areas of description and research were involved.

A review of physical and financial features

The North Island hill country is an area which accounts for around 40 per cent of New Zealand's pastoral production and which has considerable physical potential for further development. However, topographical and environmental factors impose severe enterprise constraints such that livestock production activities, especially sheep and cattle breeding, are predominant. The capital assets of the average farm tend to comprise mainly land, improvements and livestock; off-farm assets appear to be minimal compared with the value of farm assets. Average equity levels are high at around 87 per cent (Meat and Wool Boards' Economic Service 1984).

An analysis of consumption behaviour

Various general theories of consumption behaviour were investigated and associated functions tested with farm survey data (Beck and Dent 1984). Estimates of the marginal propensity to consume, based on time-series analysis using a number of functional specifications, were in the range 0.18 to 0.24 for the short term and 0.26 to 0.33 for the long term. The favoured formulation involved current consumption as a function of current income and lagged consumption.

An analysis of the use of credit

In this analysis various aspects of borrowing behaviour were explored by reviewing past credit surveys and studies, and by undertaking some statistical analyses using Meat and Wool Boards' Economic Service (1984) survey data. Some additional primary data relating to borrowing behaviour were collected.

The nominal level of long-term liabilities was found to be highly correlated with the nominal value of farm land and improvements, yet no direct causal link between increases in land values and new borrowing could be established. Rather, new long-term borrowing appeared to be prompted mainly by lagged income. While increasing land values provide the capacity to borrow, it appears that this capacity is not utilised until a period of high income improves expectations of future profitability and capacity to repay.

The amount of short-term credit used was found to be positively related to the level of working expenses and negatively related to cash reserves. Farmers need some borrowed funds to finance working expenses but appear to use less when significant liquid reserves are available. The hypothesis that farmers deliberately borrow to offset short-term slumps in income had to be rejected. Rather it appears that, where possible, farmers use their own liquid reserves to augment low income. In extended periods of low income, discretionary expenditure (especially on fertiliser, repairs and maintenance) is significantly reduced.

An analysis of factors affecting supply response

Past studies of the New Zealand pastoral sector (Court 1967; Rayner 1968; Woodford and Woods 1978; Tweedie and Spencer 1981; Laing and Zwart 1983) were reviewed and some additional analysis was undertaken with respect to North Island hill country production. The previously observed lack of short-term response to economic variables was confirmed but some short-term stocking rate response to environmental conditions was indicated. With respect to longer term responses it would appear that farmers are unwilling to increase 'long-run' stock numbers until feed production capacity is similarly increased, mainly through investment in land improvement. Such investment takes place largely out of residual funds which remain from high income years after other operating, debt servicing and consumption expenditure has been undertaken. Investment funds initially may be retained

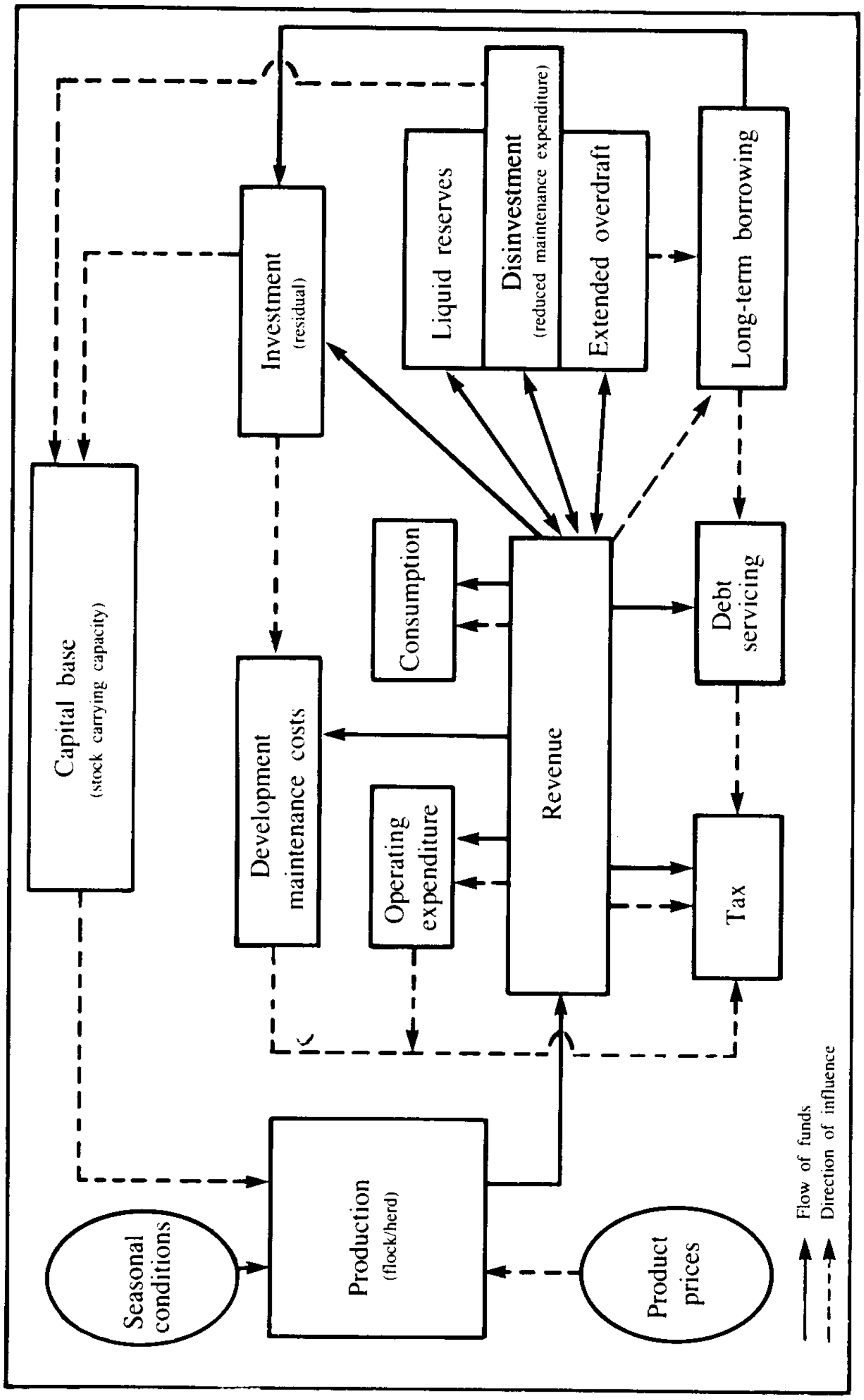

FIGURE 1—The Farm Firm System as Modelled.

as savings or liquid reserves. The rate at which stock numbers are increased to utilise improved land appears to be dependent on climatic conditions.

Land improvement, which includes clearing, oversowing, fertiliser treatment and fencing, was the major type of on-farm investment on hill country farms. In low income years it was also found to provide an important opportunity for reducing expenditure by suspending or reducing maintenance applications of fertiliser on improved pasture land. Farmers were found to favour this form of disinvestment when expenditure reductions were necessary, because pasture production falls only gradually (at least initially) when maintenance applications of fertiliser are reduced or even withheld completely (Quin 1982).

Model Description

On the basis of the system analysis summarised above, the model was developed to simulate the physical and financial operation of a representative pastoral farm over an extended time horizon, up to 20 years. The model is a 'skeleton' type model with a modular structure. The skeletal nature of the model means that all major model parameters and, where possible, decision-rule variables are read from data files and can readily be modified by the model user. This type of model provides the model user with flexibility to represent a range of farm specifications and to manipulate and experiment with the model without being unduly constrained by inbuilt assumptions (Dent and Blackie 1979).

Production, income and costs

A schematic diagram showing the main linkages and interactions between model components is presented in Figure 1. The model incorporates flock and herd submodels, both of which represent self-replacing stock breeding activities. Each year they generate farm production in the form of lambs, wool, store and fat cattle, and culled breeding stock. Annual production is a function of the current flock and herd composition and a range of production parameters; flock and herd composition are updated each year on the basis of specified mortality and culling rates which, together with production parameters such as lambing and calving rates and fleece weights, are assumed to vary primarily as functions of seasonal conditions. The seasonal variability of these production parameters and culling rates is represented by randomly selecting values from specified probability distributions.

Once total production for a given year is generated, it is valued to give gross revenue using farm-gate prices for each class of stock and for wool. These prices are stochastically generated and based on specified probability distributions. Fixed and variable costs, including operating expenditure, tax payable, debt servicing commitments and consumption requirements, are then calculated and deducted from gross revenue to give a net operating surplus or deficit. The effects of inflation and changing terms of trade are handled directly using different inflation rates for inputs and outputs.

Funds may also be borrowed at this point, depending on the outcome of a borrowing decision rule, to augment a surplus or, in some cases, to offset a deficit. However, in line with findings from the system analysis, other methods of offsetting a deficit are assumed to have higher priority than borrowing. These involve first utilising liquid reserves and then deferring maintenance (including fertiliser maintenance applications). If available liquid assets are exhausted and farm maintenance has been deferred to the extent of a specified maximum level, allowance is made for an increase in overdraft to occur. If a critical overdraft limit is exceeded for two successive years then this is interpreted as 'hard-core' debt and the overdraft is refinanced in the form of a mortgage with associated regular principal and interest payments in future years.

Given the availability of a financial surplus, augmented in some years by borrowing, a priority schedule is assumed for its disposition: (a) any outstanding overdraft is repaid; (b) any farm and fertiliser maintenance deferred in previous years is undertaken; (c) the liquid reserve fund is replenished to a target level; and (d) new investment in farm development is carried out with any funds remaining.

Adjusting stock numbers

Each investment option is represented in the model by a time profile of annual costs and associated increases in stock carrying capacity. The type of investment carried out in any year depends on a pre-specified schedule of development priorities. Allowance is made for the tax deductibility of development expenditure as appropriate. The profiles of annual increases in stock carrying capacity associated with each successive increment of development are accumulated and each year the potential carrying capacity of the farm is increased by the appropriate accumulated value.

The potential carrying capacity of the farm may also be reduced by the effects of deferred fertiliser and general maintenance. The extent of this effect is based on the estimates provided by Quin (1982) and depends on the area and duration of reduced fertiliser application. If reduced maintenance is subsequently offset by compensating increases in fertiliser applications and general maintenance expenditure, the stocking rate effects are also offset.

While farm development increases potential stock carrying capacity, this may not be reflected immediately in increases in actual stock numbers carried. The rate at which actual stock numbers are increased depends on prevailing seasonal conditions and associated culling rates. Culling rates in the model are increased in poor seasons and reduced in good seasons. Reductions in culling rates, however, occur only to the extent that the resulting increase in stock numbers does not exceed the farm's potential stock carrying capacity. Similarly, if the potential carrying capacity of the farm is lowered by reduced fertiliser and maintenance expenditure, then a culling rate is applied that will reduce actual stocking levels to match the reduced potential carrying capacity.

Model operation

For each year of the simulated operation of the farm, the major physical and financial variables are generated by the model. These include actual and potential stock numbers carried, gross and net income, tax and debt servicing commitments, consumption, operating surplus, financial reserves and overdraft levels, investment levels, net worth and equity ratio.

The simulated operation of the farm is replicated a number of times so that the model farm encounters a range of randomly generated price and production sequences. Results from the replicated simulations provide the basis for estimating probability distributions of the major model responses, thus providing a measure of the uncertainty involved in the projections.

Validation and Sensitivity Analysis

The model was designed to facilitate the representation of a range of farm specifications by varying input parameters. However, the value of the model as a policy analysis tool would be enhanced if it could be shown that the model can reproduce, with some acceptable degree of accuracy, the behaviour of a hypothetical 'average' farm. If the behaviour of the average farm can be predicted, then simple aggregation will give industry-level projections. It would be expected that aggregation bias would severely limit the value of a single representative farm model for aggregate analyses (Buckwell and Hazel 1972). In this case, however, some features of North Island hill country farming appear to mitigate aggregation bias to the extent that the model can provide results which are useful at an aggregate level.

First, North Island hill country farming is generally homogeneous with respect to output and involves a limited range of alternative production activities. Second, North Island hill country farms tend to be independent production units. Most livestock are bred on the hill country farms and supply markets external to the hill country (export markets for finished stock and flatter finishing areas for store stock). Consequently, input and output prices, which would be expected to have a major influence on the operation of hill country farms, can be regarded as exogenous at both the farm level and the aggregate farm-class level.

The model was subjected to comprehensive validation testing to assess its capacity to reproduce the historical behaviour of the 'average' North Island hill country farm over the ten-year period from 1971–72 to 1980–81. For a range of variables, modelled responses were compared with historical values. This comparison was formalised using the 'mean absolute percentage error' statistic, 'Theil's *U*' statistic and various regression statistics, together with graphical comparisons (Beck 1984). These validation tests generally indicated a close matching of simulated and historical variables and confirmed that the model has sufficient validity, in this context, to justify its use in policy analysis.

Formal sensitivity analysis indicated that the model was, in general, relatively insensitive to disturbances in most model input parameters. However, an important area of sensitivity was related to predictions of investment expenditure, which were found to be sensitive to changes in a range of model parameters, such as working expenditure, tax rates, consumption levels and borrowing assumptions. This sensitivity is inherently related to the structure of the model with its foundation in the 'residual funds' hypothesis of investment (albeit modified to account for the use of liquid reserves and deferred maintenance). Evidence from the system analysis suggests that the residual funds hypothesis of farm investment is valid, or is at least a workable explanation of actual investment behaviour. If this is true then farm investment will inevitably be sensitive to a number of factors which affect the farming operation and it is appropriate that the model reflects this sensitivity.

In contrast to investment expenditure, total stock units were found to be insensitive to changes in virtually all model parameters tested. This result is in line with findings from econometric studies in New Zealand (Woodford and Woods 1978; Laing and Zwart 1983) and can be explained by the 'buffer' provided by financial reserves and the potential to defer maintenance expenditure for some time before a significant adverse effect on stock numbers results. Similarly, significant levels of investment expenditure appear necessary before even a small increase in stock carrying capacity is achieved.

Policy Analysis

The model has been used to simulate the impact of a range of support and stabilisation policies (Beck 1984). It is used here to undertake an *ex post* examination of the farm-level effect of the New Zealand supplementary minimum price scheme and to project farm performance following the abolition of the scheme.

The supplementary minimum price scheme was a comprehensive taxpayer-funded underwriting program for export carcass meat from sheep and cattle and for export wool and dairy products. The scheme was originally presented as an interim measure (Muldoon 1978) but it continued to operate until 1984–85, and from 1981–82 provided a significant subsidy to farm incomes. The levels set for the supplemented prices were not directly linked to market conditions but were set by government.

Background

From the mid-1970s a range of government assistance measures was introduced, including the supplementary minimum price scheme. This scheme and others were presented as being necessary to help overcome balance-of-payment problems by maintaining investment confidence in agriculture and offsetting costs imposed on agriculture by distortions elsewhere in the economy. A positive view of market outlook was adopted and the assumption was made that New Zealand was a price taker (Durbin 1985). Increased pastoral production was sought in an attempt to exploit the perceived market potential.

In the late 1970s and early 1980s, however, difficulties developed with traditional markets, particularly for sheep meats. The European Community's sheep meat regime and other policies encouraged EC production and undermined export markets. In the context of expanding supplies and contracting traditional markets, sustained downward pressure on prices was inevitable. However, the setting of the supplementary minimum prices by government did not reflect this decline in market prices and substantial subsidising of prices occurred in the years 1981–82 to 1983–84. This price subsidisation cost the New Zealand taxpayer $NZ220m in 1981–82, $NZ351m in 1982–83 and $NZ295m in 1983–84 (Chudleigh, Greer and Sheppard 1983; Ministry of Agriculture and Fisheries 1984).

The budgetary cost of the supplementary minimum price scheme and its distorting effect on producer prices became a major economic issue in 1983–84 and, in line with a general policy of deregulating the New

Zealand economy, the decision was made to phase out the scheme during the 1984–85 production season. As a transitional move toward a more market-oriented pricing system, final lump-sum payments equivalent to the anticipated supplementary minimum price payments for the 1984–85 season were made to the Meat and Wool Boards.

Farm performance with and without supplementary minimum prices

The first analysis conducted with the model was a deterministic comparison of average farm performance with and without supplementary minimum prices for the period 1981–82 to 1983–84, that is, the period when the supplementary prices provided substantial price subsidies. Where possible, model starting conditions were set to match North Island hill country average conditions at the end of 1980–81 as recorded in the Meat and Wool Boards' Economic Service (1983) farm survey. Other model parameters, related to reserve limits, proportions of reserve and borrowed funds invested, investment profiles, debt servicing allowances, and the consumption function, were based on system analysis results published by Beck and Dent (1984) and summarised above.

The model was run once with historical market prices for the years 1981–82 to 1983–84 to give the 'without subsidy' scenario. Then, for the scenario based on subsidised prices, actual supplemented prices were used for the same period. Production parameters for the scenarios were based on published historical data from the Meat and Wool Boards' Economic Service farm surveys. The results are discussed below. Projections for gross revenue, consumption and deferred maintenance are presented graphically in Figures 2 to 4.

Clearly, the supplementary minimum price scheme had a significant effect on average gross revenue during the period 1981–82 to 1983–84 (see Figure 2). The model projections indicated that this effect ranged from a revenue supplement per farm of around $NZ17 000 in 1981–82 to $NZ10 000 in 1983–84

Annual consumption (Figure 3) increased as a result of the subsidy by between $NZ2700 and $NZ3600 during the period 1981–82 to 1983–84, and an average of $NZ2400 extra tax was paid each year. Reserve deposits and off-farm investments at the end of the period were $NZ9300 higher than they would have been without supplementary minimum prices.

The responses described above indicate various 'sinks' for the subsidy revenue which do not directly maintain or increase the productive resource base of the farm, that is, increased consumption, taxation and reserves. Given that one of the stated objectives of the supplementary minimum price scheme was to encourage production, the effect of the subsidised prices on the projected levels of deferred maintenance and on-farm investment is of particular interest. Model results indicate that the level of deferred maintenance in the period 1981–82 to 1983–84 would have been substantial in the absence of the subsidy, accumulating to a level of nearly $NZ16 000 per farm by the end of 1983–84 (see Figure 4). With the price supplement, deferred maintenance occurred only in 1983–84 and only to the extent of approximately $NZ2000 per farm. In neither case was there significant investment over this period.

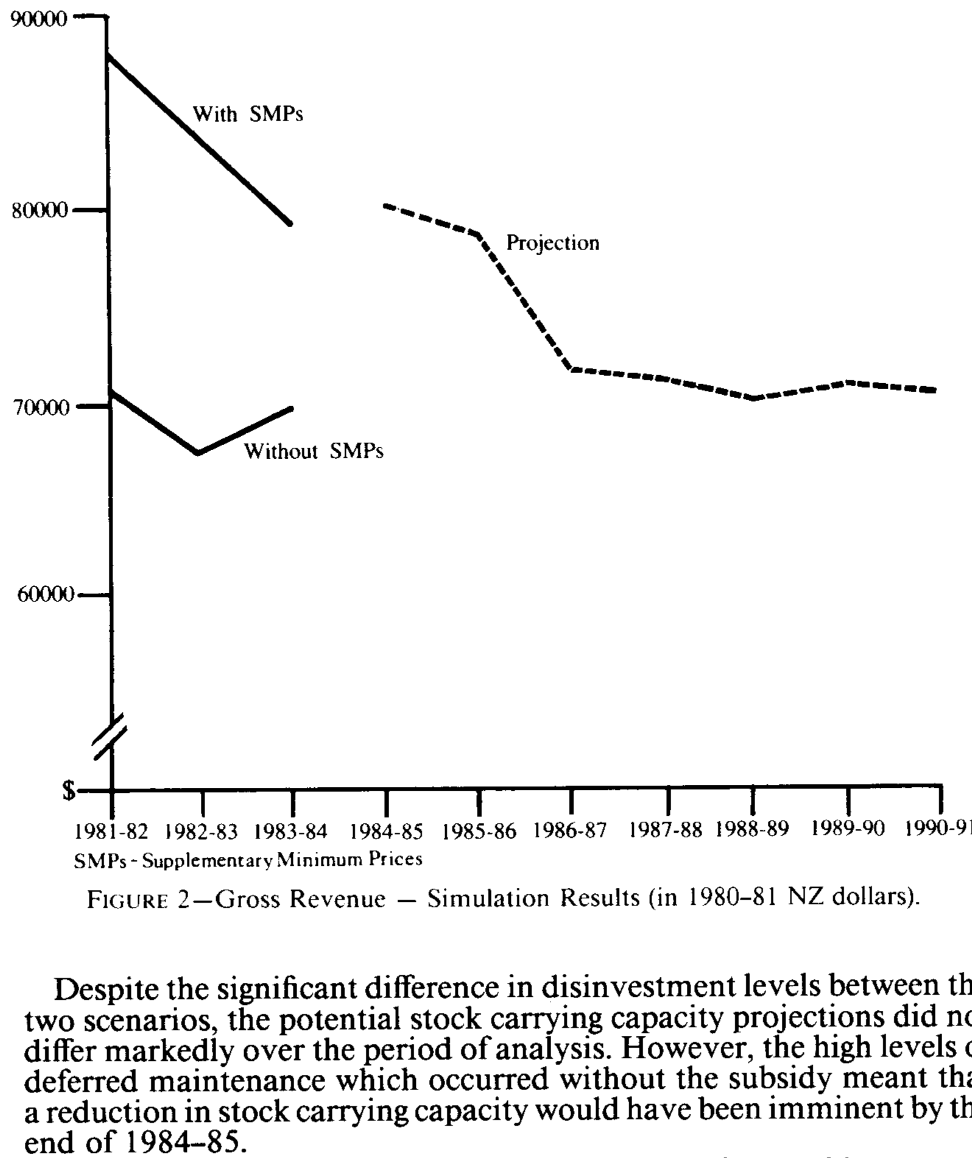

FIGURE 2—Gross Revenue — Simulation Results (in 1980–81 NZ dollars).

Despite the significant difference in disinvestment levels between the two scenarios, the potential stock carrying capacity projections did not differ markedly over the period of analysis. However, the high levels of deferred maintenance which occurred without the subsidy meant that a reduction in stock carrying capacity would have been imminent by the end of 1984–85.

The fact that an erosion of stock carrying capacity would not occur until after four years of low prices reflects the 'buffering' effect referred to earlier. The impact of a significant reduction in income can be absorbed for some time through reduced consumption, taxation, reserves and maintenance spending, without seriously impairing the productive base of the system. Similarly, an increase in gross revenue seems likely to be distributed to a number of uses, most of which will not have a direct impact on the productive capacity of the farm.

Disposition of extra revenue

The model provides a method of estimating the relative disposition of the extra revenue provided by supplementary minimum prices over the simulated period. The differences between the levels of various categories of expenditure with and without supplementary minimum prices were found and these differences then expressed as percentages of the

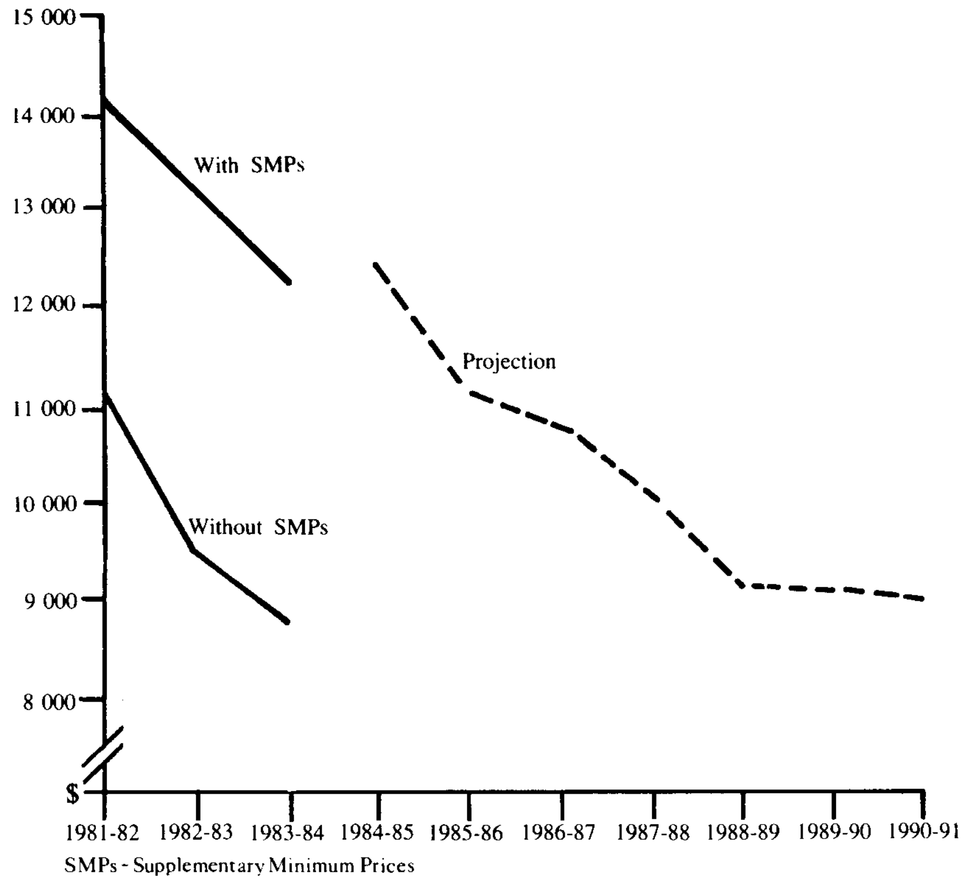

FIGURE 3—Consumption — Simulation Results (in 1980–81 NZ dollars).

increased gross revenue attributable to the subsidy. The distribution of the extra income from the subsidy alone cannot be determined precisely because of the dynamics of the system, the growth of the farm over time and the effect of extra income on funds borrowed; however, the estimated figures provide a useful insight into the effect of direct price subsidies. The results are shown in Table 1.

An increase in general expenditure accounted for approximately 20 per cent of the increased revenue resulting from supplementary minimum prices. In the model this item includes debt servicing costs and discretionary operating costs, both of which increase as revenue increases. Increased consumption accounted for another 20 per cent of the increased revenue, while increased taxation was of the order of 14 per cent. It is significant to note that only 28 per cent of the value of the subsidy over the three years was used to maintain production through farm maintenance that would not otherwise have been undertaken. The balance of the subsidy (18 per cent) was allocated to reserve deposits and other off-farm investments.

Farm performance after removal of supplementary minimum prices

As a second phase of the policy analysis, the performance of the modelled farm following the removal of the supplementary minimum

TABLE 1

Estimated Distribution of Extra Revenue from Supplementary Minimum Prices (1981–82 to 1983–84)[a]

	$	Percentage of total
Extra revenue from subsidy	42 800	
Extra funds borrowed	7 700	
Total extra funds	50 500	100
Expenditure including extra debt servicing	10 150	20
Consumption	9 900	20
Taxation	7 300	14
Maintenance expenditure	13 900	28
Reserves and investments off-farm	9 300	18
Total extra funds	50 500	100

[a]All amounts are expressed in 1980–81 New Zealand dollars.

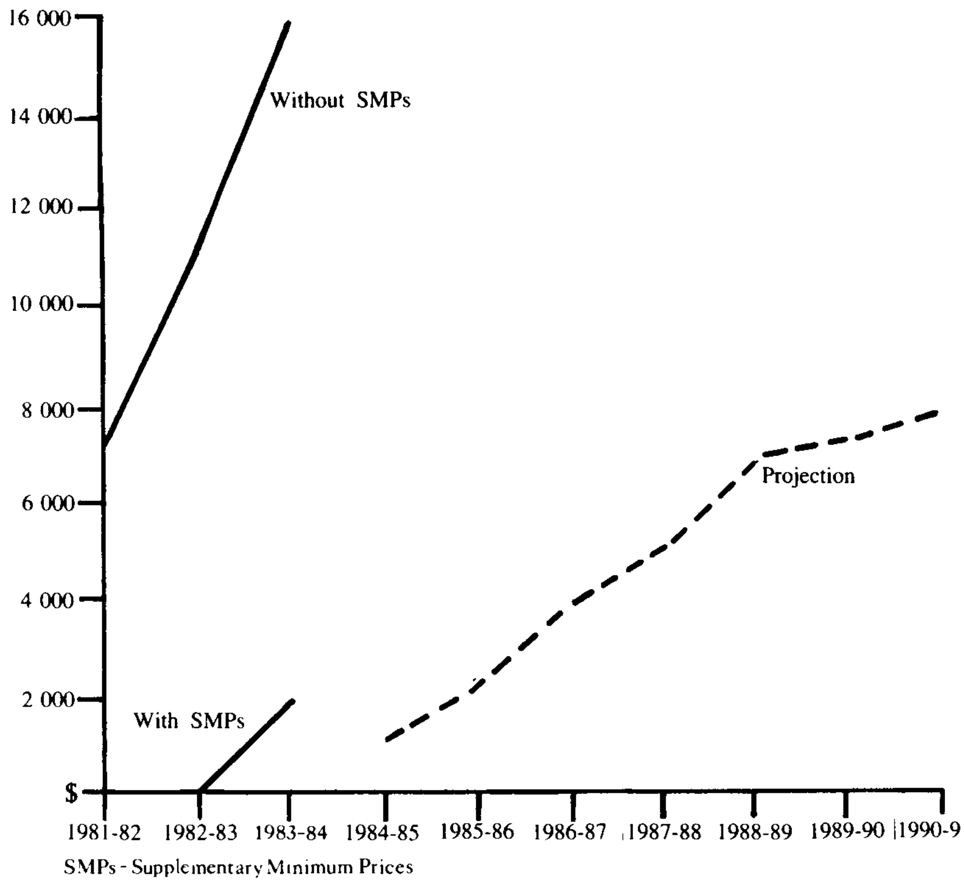

FIGURE 4—Deferred Maintenance — Simulation Results (in 1980–81 NZ dollars).

price scheme was projected to 1990–91. To account for price and seasonal uncertainty, the model was run stochastically with probability distributions specified for the price and production parameters. The distributions for production parameters such as wool cut per head and lambing and calving rates were based on historical frequencies.

For the commodity prices used in the projection a structural decline was assumed to have occurred relative to historical levels. The low product prices of the early 1980s were regarded as indicative of a permanent decline in real price levels rather than a short-term aberration. To represent this, price distributions were determined using historical frequencies for the 15-year period 1966–67 to 1980–81 and these were then reduced by 20 per cent. A continuing 2 per cent decline in the farm terms of trade was also assumed. Results of the simulation are outlined below, with projections for selected model responses shown graphically in Figures 2 to 4.

The price assumptions led to a declining trend in real gross revenue, with a mean over the period of approximately $NZ75 000 a year (in 1980–81 dollars). Initially, this represented an increase in revenue relative to that which would have been received in 1981–82 to 1983–84 in the absence of the subsidy (see Figure 2). However, by the end of the projection period revenue levels were at the (unsubsidised) levels of the early 1980s. A relatively large standard deviation was indicated for this annual gross revenue, typically around $NZ10 000.

Mean operating expenditure declined only slightly in real terms and this led to a low and declining after-tax cash surplus which in turn resulted in a significant decline in consumption. Consumption was projected to fall from a peak of $NZ12 500 in 1984–85 to just over $NZ9000 in 1990–91 (Figure 3). Standard deviations of between $NZ1800 and $NZ2000 were generated for annual consumption, indicating that in some circumstances the pressure on consumption would be substantially greater than is suggested by the average result.

Such adverse conditions were similarly reflected in investment and maintenance projections (Figure 4). Virtually no new investment was possible under these conditions; rather, significant disinvestment in the form of reduced farm maintenance was indicated. The value of deferred maintenance rose steadily, from $NZ1200 in 1984–85 to nearly $NZ8000 in 1990–91. The standard deviation generated for this final-year value was $NZ5600, confirming the sensitivity of this variable to changes in farm revenue.

After 1987–88 the stock carrying capacity began to decline and continued to do so at an increasing rate as the extent of deferred maintenance increased. It would appear that, given prolonged adverse economic conditions, production stability could not be expected to last much more than four years. By that time much of the financial and physical reserves of the farm would have been depleted and the production effects of disinvestment would be appearing.

These results indicate that stock numbers, and thus total production, are price inelastic. In contrast, consumption, taxation, reserve level, maintenance and investment are relatively sensitive to price changes. Price elasticities for a range of model responses were calculated and are presented in Table 2. The elasticities were estimated by varying prices

TABLE 2

Price Elasticities for Model Responses

Model parameter	Elasticity
Gross revenue	1.01
Expenditure	0.55
Consumption	1.66
Taxation	1.82
Reserves	1.86
Maintenance	44.00
Total assets	0.42
Equity (per cent)	0.11
Borrowing	2.26
Investment	5.00
Potential stock units	0.17
Actual stock units	0.05

and running the model for a ten-year period. The changes in the projected year 10 model responses were taken as a measure of the long-term sensitivity of these responses to a permanent price change.

Discussion and Conclusions

Short-term to medium-term stability in production appears to be an inherent feature of the farming system modelled in this study. This suggests that short-term underwriting is unnecessary if the objective of the policy is to maintain production stability. It also indicates that substantial subsidies could be paid without resulting in a significant or long-term increase in production.

Even less justifiable is an underwriting scheme that is not directly linked to market conditions. Such was the case with the supplementary minimum price scheme. With the 'optimistic' support levels set for 1981–82 to 1983–84, the scheme served largely to supplement farm sector consumption and non-productive expenditure, and effectively insulated the pastoral sector from the realities of the marketplace at a time when important structural changes were occurring in world markets for pastoral products.

With the subsequent abolition of the scheme and other rural sector support measures, the changes necessary to adjust to the market conditions are now occurring. It seems reasonable to conclude that the scheme served to delay the necessary adjustment process, at considerable cost to the New Zealand taxpayer.

This is not to deny that the adjustment process would have been (and is currently) a painful experience for many farmers, particularly those with little scope for diversifying away from extensive pastoral production. Farms with limited physical or financial (or managerial) resources, such as those in the early stages of development or carrying high debt loads, are being severely affected and are more vulnerable to adverse economic conditions than the average farm. The emphasis in New Zealand rural policy is now placed on adjustment and welfare considerations. Policies have been introduced recently to encourage commercial restructuring of debt and to facilitate farmer access to welfare assistance and alternative employment opportunities (Moyle and Douglas 1986).

With respect to the general value of simulation modelling in the context of policy evaluation, there appears to be considerable potential for the development of models which can simulate a range of policy scenarios within a framework which represents the main dynamic and stochastic aspects of a farming system. Such models also provide the basis for representing a range of farm configurations and for describing policy responses in terms of a number of farm performance parameters.

It is important, however, not to overlook the limitations associated with this type of model. The aggregation problem, for example, must be considered when using any model of this genre. If the model is to be used to draw conclusions about the behaviour of a group of farms, then analysts should be aware of the potential for aggregation bias. There may be some scope for combining separate representative simulations to arrive at an aggregate projection. However, in some cases, particularly where a less than perfectly elastic demand is faced, a different type of model which accounts for aggregate supply and demand behaviour may be more appropriate.

Nevertheless, there is potential for adapting the model used in this study to simulate other pastoral systems. The model was designed so that flexibility is possible through input data without the need for structural changes. There is a limit to this flexibility but production systems involving predominantly sheep or beef breeding activities can be accommodated. Different production activities could be handled by the development of new production submodels.

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