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THE INFLUENCE OF GRAIN FREIGHT RATES ON THE FARM LAND MARKET IN THE PRAIRIE PROVINCES

by

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A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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ABSTRACT

This study tests the hypothesis that the statutory freight rates have increased farm land prices in the Prairie provinces. This hypothesis is based upon the assumption the statutory rates act as a subsidy on farm-gate prices. According to economic theory, if the subsidy is anticipated to be permanent, it will be capitalized into the price of the fixed factor controlling access to the subsidy. That is, such a subsidy will be capitalized into farm land prices.

The basic analytical model used in the analysis is a land price model. Farm land prices are expressed as a function of present expected crop cash flow payments and farm land prices in the previous year. Formulation of expected crop cash flow levels is central to this model. Its development requires additional models and procedures. A crop yield model is specified to determine expected yield levels on stubble and fallow seedbeds of the principal crops grown in the Prairie provinces. In addition, a fallow/stubble acreage model and a fertilizer application rate model are incorporated to calculate future expected crop cash flow levels. These models account for decreasing summerfallow acreages and increasing fertilizer application rates. Using required increases in statutory rates in 1974 and 1977 estimated by Snavely as benchmark levels, appropriate price indexes are applied to cost categories of the railways in these years to derive an index for compensatory freight rates.

The statistical relationships determined for each province from the land price model are employed to simulate farm land prices under various transportation rate structures. The differences in the farm land price simulations from 1961 to 1979 under statutory versus compensatory rates reveal 14, 17 and 28 percent of the 1979 farm land values in Manitoba, Saskatchewan and Alberta, respectively, can be attributed to the unremunerative rates. In terms of total farm land acreages, this implies farm real estate values have increased by $7 billion in the Prairies over the period from 1961 to 1979 as a result of the statutory rates. When compared to costs of $1.9 billion absorbed by taxpayers and the railways, it appears a transfer of funds in favour of landowners has occurred.

Over time, the distribution of the benefits of the statutory rates among farms has not changed to any significant degree and is quite similar in each province. Half the benefits are received by 25 percent of the farms while the remaining half is evenly split between 50 and 25 percent of the farms. Landowners who sold land since the statutory rates became unremunerative have already realized an increase in their wealth since such land sales took place at inflated prices. Farm land investors, who consist largely of established farmers or new entrants, are both adversely affected by rising land prices. But, established farmers are compensated to the extent their equity also increases. Consequently, the increase in farm land values caused by the statutory rates has redistributed wealth in favour of established farmers who already own a considerable amount of land.

Farm land prices are also simulated for the years 1980 to 1990 based upon three scenarios of projected transportation rates. One series represents a continuation of statutory rates, another compensatory rates, and a third, subsidized rates where producers receive the 'crow benefit' realized in 1980. Statutory rates indicate a continuation of the rate of capitalization of the benefits into farm land prices as has been experienced. The adoption of the subsidized rates serves as a means of transition from statutory to compensatory rates. Meanwhile, during this transition, the benefits of the subsidy become capitalized into farm land prices. Consequently, even though land prices in 1990 are suppressed as compared to those under statutory rates, they are still much higher relative to those under full compensatory rates.

Numerous compensation schemes have been proposed for changing the grain rate structure. All compensation scheme proposals involve an explicit or implicit subsidy to western grain producers and require financing from public funds. In view of the capitaliztion of such subsidies into farm land values, it is difficult to justify such an income transfer. If compensation takes place, it should be done in a manner which will circumvent the capitalization problem discussed in this study. Producers must be forced to incur full compensatory rates and receive compensation in a manner which is not attached to either the volume of grain marketed or acreage of landownership. That is, compensation must be linked to individuals not grain or land. In addition, this compensation should take the form of a lump sum payment in order to ensure the recipients view it as a windfall gain and not as income attached to the earning capacity of farm land.

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Chapter I

INTRODUCTION

Research in Canadian transportation and agricultural policy has seen extensive amount of time and effort expended upon examining the inefficiencies in the movement of Prairie grain.[1] The statutory freight rates, more commonly known as the Crowsnest pass rates, have been singled out as one of the major contributors to the existing inefficiency in grain movement. The rates are fixed by Federal statute. They apply to rail transportation of all export movements of grains, certain feed products and grain by-products, from all Prairie points to Vancouver, Prince Rupert or Churchill and; to both export and domestic movements from any point west of Thunder Bay to Thunder Bay or Armstrong.

The statutory freight rates developed as an extension of the Crowsnest Pass Agreement of 1897. In the agreement, a substantial subsidy was made available to the Canadian Pacific Railway company by the Federal Government to build a rail line from Lethbridge, Alberta, through the Crowsnest Pass, to Nelson, British Columbia. In return for this subsidy, the Canadian Pacific Railway company agreed to make several

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[1] The following publications provide further discussion on issues in Canadian transportation and agricultural policy: E.W.Tyrchniewicz, "Transportation Problems in Canadian Agriculture with Special Reference to Grains", Canadian Journal of Agricultural Economics, July 1976, pp. 18-31; and J.Richter, "Perspectives on the Role of Freight Rates in the Marketing of Canadian Agricultural Products," in Freight Rates and the Marketing of Canadian Agricultural Products (eds. R.M.A.Loyns and E.W.Tyrchniewicz), Occasional Series No.8, Department of Agricultural Economics, University of Manitoba, August 1977.

concessions to the government. One of those concessions was the Crowsnest Pass grain freight rates for grain and flour moving from the West to the Lakehead. Among the reasons[2] why the Federal Government undertook the agreement with the Canadian Pacific Railway company were expansion of the economy, further development of export markets, and the assertion of national sovereignty. In 1925, the Crowsnest Pass Agreement was dissolved and amendments were made to the Railway Act. Those amendments made the Crowsnest freight rates statutory for movements of Prairie grain and flour to the Lakehead. Subsequent changes to the Railway Act extended the rates to export movements from the Prairies to the Pacific ports and Churchill. In addition, alterations were made to the grain categories covered.

Contemporary arguments for retention of the statutory rates generally revolve around their benefits to national interests through improving the welfare of Prairie farmers. It is argued Prairie grain producers, because of their geographical location and resulting dependence upon rail transportation, are at a disadvantage relative to their competitors in world grain markets. Instability in world grain prices adds further support to the argument that western producers cannot absorb higher transportation charges and still effectively compete in world markets. Maintenance of the western grain producers' competitive position is argued to be of national interest considering the grain and oilseed trade is a major foreign exchange earner.

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[2] A discussion of historical perspectives surrounding the Crowsnest rates may be found in: C.D.Nachtigall, G.F.Skinner and E.W.Tyrchniewicz "Crowsnest Pass Grain Rates: Time for a Change?", Canadian Transportation Research Forum: Proceedings---Sixth Annual Meeting Vol. XVI, No. 1, 1975.

Since World War II, the railways have maintained the costs of shipping Prairie grain have exceeded the revenues received under the statutory rates. These rates have failed to meet the compensatory criteria defined by the National Transportation Act of 1967. Consequently, the level of the rates imposed on the railways in relation to the costs incurred has been the subject of much inquiry. The impact of the rates on the grain industry is of pertinent significance considering the present objective in the grain industry to sell more grain to an expanding export market.

Following the work of the Commission on the Costs of Transporting Grain by Rail,[3] there has been fairly wide recognition and acceptance that the statutory rates have caused the two major railways to experience a revenue shortfall. In 1974, the Commission established under statutory rates, the users of the service contributed 38.9 percent of the total cost incurred in transporting the statutory grains. The follow-up report by Snavely, King and Associates[4] in 1977 found the users' contribution fell to 32.4 percent as compared to 36.3 percent[5] in 1974 (see Table 1). The forces of inflation over the period from 1974 to 1977 were circumvented to a considerable extent by increased efficiency

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[3]The Commission on the Costs of Transporting Grain by Rail, Report Vol.I, Supply and Services, Ottawa, Canada, 1976.

[4]Snavely, King and Associates, 1977 Costs and Revenues Incurred by the Railways in the Transportation of Grain Under Statutory Rates, report prepared for the Ministry of Transport, Federal Government of Canada, Washington, D.C., September, 1978.

[5]The discrepancy in the users' contribution between the two reports may be accounted for by the choice of the capital funds rate applied to Canadian Pacific Rail. The latter study chose to apply the same rate to both Canadian National as well as Canadian Pacific Rail.

TABLE 1

1974 and 1977 Cost Comparison of Transporting Statutory Grain by Rail

Source	Amount of Cost Coverage	
	Total Dollars (million)	Distribution (%)
1974		
Users of the Service	89.7	36.3
Federal Government	52.0	21.0
Railways	105.4	42.7
TOTAL	247.1	100.0
1977		
Users of the Service	114.8	32.4
Federal Government	63.7	18.0
Railways	175.5	49.6
TOTAL	353.9	100.0

Source: Snavely, King and Associates, 1977 Costs and Revenues Incurred by the Railways in the Transportation of Grain Under Statutory Rates, Report prepared for the Ministry of Transport, Federal Government of Canada, Washington, D.C., September, 1978.

in the railways' operations and government expenditures for additional hopper cars. Given the trend in the annual rate of inflation, future revenue shortfalls may be anticipated to continue. Concern has been directed accordingly towards determining a procedure whereby the railways can be adequately compensated for the shortfall.

The statutory rates on grains provide such a low return for the railways, they no longer have the physical or economic capacity to underwrite the losses incurred on grain traffic.[6] Therefore, the railways lack the incentive to give at least equal priority to grain as other traffic. Consequently, the grain transportation system has deteriorated as the railways have deferred maintenance and capital expenditures, especially on the lines carrying a greater share of grain traffic. Since 1972, expenditures for railway plant and equipment used in the transportation of statutory grain has been financed largely with public funds. Without suitable compensation to the railways, potential grain export levels are unlikely to be attained because of inadequate investment in plant and equipment used in grain transportation.

The present rate structure has not been criticized only for inducing a misallocation of economic resources with respect to the grain transportation and handling system but, also with respect to primary agricultural production.[7] It is argued the rates discourage livestock

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[6] Booz-Allen & Hamilton, Inc. and IBI Group, Grain Transportation and Handling in Western Canada, report prepared for the Department of Industry Trade and Commerce, The Grains Group, Federal Government of Canada, July 1979.

[7] The following report provides an overview of these problems of transportation in western Canadian development, as well as, references to numerous articles published on the subject: W.W.Wilson and

production and value-added processing activities in the Prairies. Less than compensatory freight rates on grains versus livestock induces, ceteris paribus, a production shift in favour of land being allocated to grain production. In addition, it is argued, feed grain prices are higher, ceteris paribus, because of the inherent subsidy on grains exported from the Prairies, adding to the costs for livestock production over grain production. As a counter argument, the existing inefficient, and consequently congested grain handling and transportation system, may have resulted in a larger supply of feed grains for Prairie livestock producers. In this case, the suppressed freight rates may be identified as also having benefitted Prairie livestock producers. Non-optimal location decisions also may have occurred with respect to processing plants of most agricultural products. The absence of unfavourable rate differentials would have encouraged, ceteris paribus, the location of such plants close to the source of raw material, that is, in western Canada. Consequently, it may be argued the preferential rates on grains have retarded the economic development of western Canada. But, other factors besides freight rates influence processing locations. Therefore, absence of those rates would not necessarily have resulted in the location of processing in western Canada.

The principal crops grown in the Prairie provinces are wheat, oats, barley, rapeseed and flaxseed as they constitute well over 90 percent of all crops grown. These crops all move under the statutory freight

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E.W.Tyrchniewicz, The Role Of Transportation In The Development Of Western Canadian Agriculture, a special report prepared for the Canada West Foundation Task Force on the Role of Agriculture in the Economic Development of Western Canada, Department of Agricultural Economics, University of Manitoba, Winnipeg, Manitoba, January, 1980.

rates. If grain freight rates rise, all statutory crops are affected equally. Consequently, there would be no incentive initially on the part of producers to alter relative production levels of the principal crops. A possible response may involve a shift either to non-statutory crops or forages. But, Prairie acreages allocated to statutory crops appears to be highly price inelastic when they are considered in aggreagate. Colman[8] estimated an equation for the total acreage of the five principal crops in western Canada. He included a variable reflecting the expected average return per acre of Prairie grains and oilseeds. But, the variable was unable to reveal any statistical significance. Prairie producers respond to changes in relative prices of the principal crops by shifting the share of land seeded to each crop but have not altered the cultivated land area because of crop prices. Although aggregate acreage levels appear to be highly price inelastic, production levels may still be altered depending upon how responsive fertilizer application rates or summerfallow acreages are to a shift in grain prices. Even if these factors are price responsive, their influence on production levels would be minimal relative to the impact acreage levels would have. Given such a high degree of price inelasticity of supply of these crops, if freight rates rise, the initial impact would be for farmers to absorb the additional cost if international grain prices remain at the same level.

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[8]David Colman, "Prairie Grain and Oilseed Acreages Response", Working Papers, No. 7, Agricultural Canada, Policy, Planning and Economics Branch, November 1979.

Removal of differential freight costs between raw and processed grains and oilseeds may be argued to encourage processing of these crops in the Prairies. But, unless such processors are able to exercise world market power, there is no incentive on their part to provide higher prices to producers in order to obtain larger supplies. That is, producers would be relieved of some of the burden of higher freight costs only if processors are able to pass this cost onto foreign buyers. Furtan et al[9] claims a significant portion of the benefits of the statutory rates on rapeseed is captured by the Japanese market. But, their model holds rapeseed production fixed on the Prairies. Unless processors create a relative difference in prices between rapeseed and the remaining statutory crops, and hence, increase rapeseed production levels, there would be no incentive for processors to pass on some of the freight costs to foreign buyers. Although Canada is a major rapeseed producer, the extent of its market power is still in question considering its size relative to the much larger soybean market in which it must compete. In addition, in the 1978-79 crop year, rapeseed exports accounted for only 9 percent of the total exports of statutory grains and oilseeds from the Prairie provinces. At the same time, wheat accounted for 67 percent of those exports. MacLaren[10] attempted to determine the economic power Canadian wheat exports possess in world markets by examining the price elasticity of the excess demand function

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[9] W.H.Furtan, J.G.Nagy, and G.G.Storey, "The Impact on the Canadian Rapeseed Industry from Changes in Transport and Tariff Rates", American Journal of Agricultural Economics, Vol.25, No.1, February 1977, p.31-54.

[10] Donald MacLaren, "Canadian Wheat Exports in the International Market: An Exploratory Econometric and Policy Analysis", Canadian Journal of Agricultural Economics, Vol.25, No.1, February 1977, p.31-54.

facing those exports. The short-run price elasticity of excess demand was found to be -3.6 with a corresponding long-run elasticity of -13.5. Therefore, he concluded the excess demand function facing Canadian wheat exports is highly price elastic.

In conclusion, the supply of statutory grains and oilseeds from the Prairie provinces displays a high degree of price inelasticity, and there is limited opportunity for increasing the price elasticity through increased processing activities. It follows the initial impact of the statutory rates has been to artificially raise grain and oilseed prices received by Prairie grain producers. Consequently, if grain freight rates rise, farmers would have to absorb the additional cost if international grain prices remain at the same level. Acting as a subsidy on grain prices, the rates have favoured the production and export of grain. But, the higher grain prices undoubtedly initiated an adjustment process with associated repercussions throughout the economy. Policy advisors need to be cognizant of such adjustments when proposing compensatory schemes in order to minimize the detrimental impacts upon the railways and the economy as a whole. This study examines one secondary implication of the statutory rates to grain producers. Specifically, the effects of the higher grain prices upon farm land prices in the Prairie provinces is examined.

A causal relationship is hypothesized to exist between grain and farm land prices in the Prairie provinces. This is developed from the influence of grain prices on grain producers' net income. Net income (defined as total crop receipts minus all costs other than a return to

land, management and operator labour) is at a higher level because of the statutory freight rates. Since the rates are set by statute, farmers and other real estate investors likely have perceived a continuance of the higher levels of net income. According to economic theory, whenever an increased income stream is anticipated to be permanent, it will be capitalized into the price of the fixed factor controlling access to the income stream. Therefore, statutory freight rates should have increased farm land prices in the Prairie provinces. Landowners of grain land are then the primary beneficiaries of this capitalization process.

The hypothesized capitalization of the statutory freight rates into farm land prices may create a less than equal distribution of wealth as well as, a barrier of entry into the farm real estate market. Maintenance of the unremunerative transportation rates has required taxpayers and the railways to absorb any additional costs in transportation in order to provide continued service. A number of Federal Government programs such as the branch line subsidies, the box car repairs, the grain hopper car purchases and the branch line rehabilitation rely upon public funds. Those costs need to be evaluated against the increased wealth of landowners. Landowners who sold land since the statutory rates became unremunerative have already realized the increase in their wealth. At the same time, however, this has placed a premium on the purchase price of farm land which has been absorbed by recent investors. Consequently, the number of farmers and other real estate investors eligible to bid in the market is affected by their ability to absorb the premium. In addition, the distribution of the benefits, through the capitalization process among landowners needs to be examined.

The purpose of this study is to examine the impact of the statutory freight rates upon land prices in the Prairie provinces and, to determine the implications this impact has had with regards to wealth distribution. This objective is pursued through various stages of analysis. At a first stage, a relationship between farm land prices and expected crop cash flow levels is theoretically developed and empirically tested. In order to ascertain expected crop cash flow levels, information is required on changes in crop yields, acreages, prices, as well as, input useage. A separate crop yield model is specified to determine expected yield levels. Changes in the other components of expected crop cash flow are generally taken as they occurred. Using the model developed, the next stage involves historical simulations of farm land prices. First, using the expected crop cash flow levels derived, actual farm land prices are simulated. Those prices are again simulated but, with expected crop cash flow levels adjusted to the extent crop prices received by farmers would fall if compensatory transportation rates are charged. A series of compensatory rates are developed through the use of an indexing procedure based upon the benchmark levels established by Snavely et al. Those benchmark levels represent the amount by which statutory rates would have to rise to be compensatory. Given this information, the implications of the statutory rates with regards to wealth distribution is examined. As a final stage, future farm land prices are simulated based upon various assumptions regarding possible transportation policies.

Chapter II presents a review of the underlying theory and related studies. The specification of the various analytical models as well as

simulation procedures and data sources are provided in Chapter III. The empirical results are discussed in Chapter IV. Chapter V summarizes the study and examines policy implications.

Chapter II

ECONOMIC THEORY AND RELATED STUDIES

The working hypothesis in this study is that the statutory freight rates have increased farm land prices in the Prairie provinces. A supporting argument is developed, in the following chapter, by examining the theoretical aspects of economic rents earned by fixed factors of production. Specifically, the economic rents earned by farm land are examined with a view to demonstrating the impacts of technological change, as well as the statutory rates, on those rents. Next, the land investment decision criteria in terms of the maximum bid-price concept is put forth. Finally, various studies attempting to explain farm land price movements are reviewed.

2.1 LAND PRICES AND ECONOMIC RENTS

Resource pricing plays a key role in the operation of a market economy. It is important in determining the employment and allocation of resources. But, perfect mobility of all resources does not occur, even in the long run. The returns received by fixed resources are not determined according to the usual resource principles. In a perfectly competitive market, mobile resources receive amounts equal to the values of their marginal product in alternative employments. The remuneration to fixed resources then becomes the residual once the mobile resources have been paid the amounts required to employ them in the firm. This residual is commonly called economic rent.

The concept of economic rent, as discussed, refers to the surplus which any factor of production earns above the income necessary to keep it employed. In a strict sense, rent can only be earned by a factor while its supply is fixed. Since the supply of land is finite, even in the long run, the term rent is usually applied to payments for the use of land. Therefore, any factors affecting the level of economic rent may be anticipated to influence land prices.

The level of economic rent to farm land is dependent upon the relative elasticities of demand for and supply of land using products. It was argued in the previous chapter, the supply of agricultural output of the principal crops displays a high degree of price inelasticity. Concurrently, producers face a perfectly elastic demand for their crop. Given these relative elasticities of demand and supply, a cost-price diagram for an individual farm will help to depict the nature of economic rent. In Figure 1 , the marginal cost curve, MC, is given for an individual farm producing crop X. Under perfectly competitive conditions, at a market price of the crop of P, the farm's output level will be X_0. At this price and output level, total receipts to the farm exceed necessary payments to the variable resources by an amount equal to area a. The fixed resources receive these receipts in terms of economic rent.

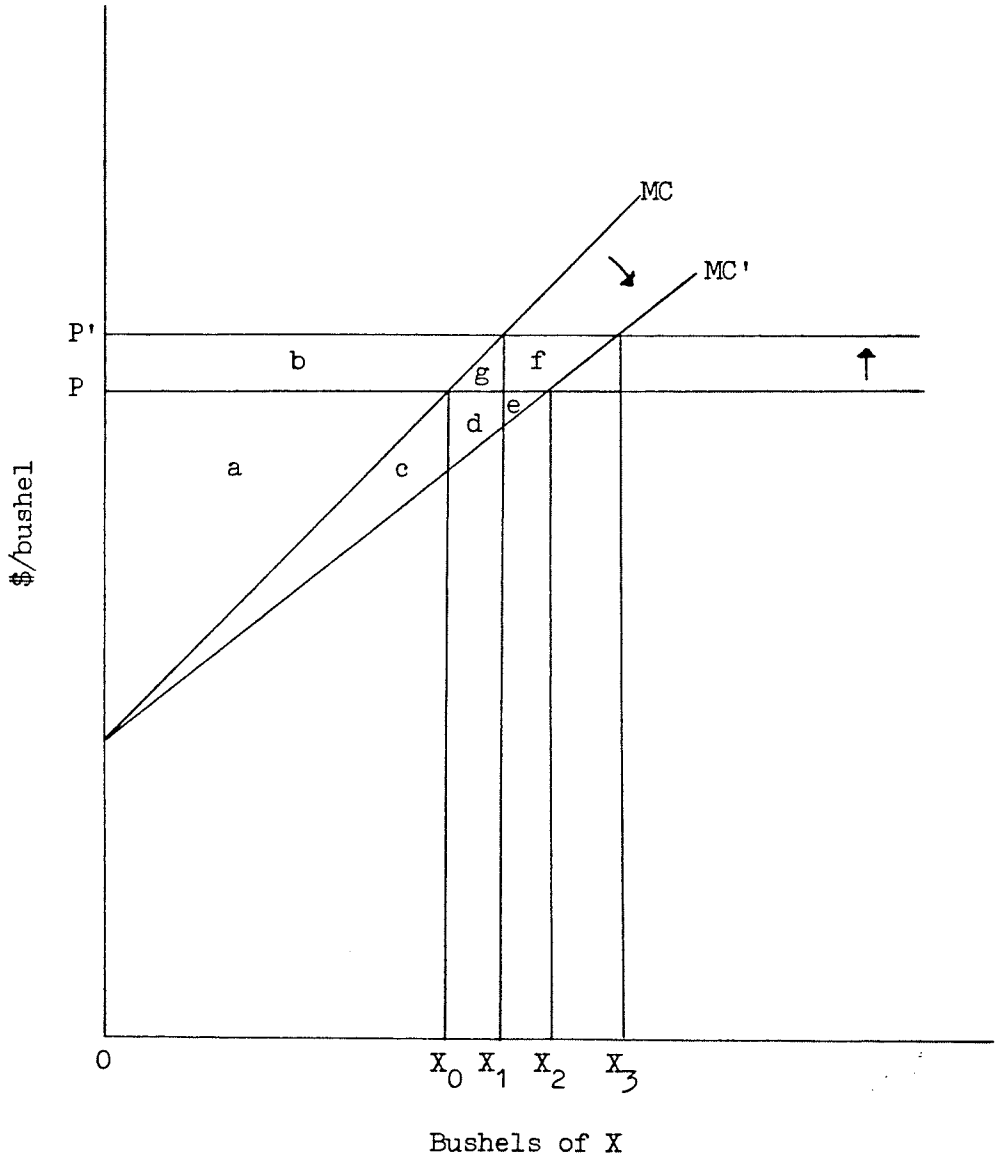


Figure 1

Economic Rents to Fixed Factors of Production

Economic rent earned by the fixed factors will increase for the firm through alterations either on the revenue or expense side. That is, if at the same cost per unit of production total earnings are increased for a given level of production, economic rent increases. Secondly, if the per unit cost of production can be decreased, economic rent again will rise.

2.1.1 Statutory Rates

The statutory rates have fixed the freight charges for grains and oilseeds on the Prairies. For example, on average, grains in Manitoba are charged $0.16 per hundredweight for transportation. This serves to decrease the average price received by producers by a fixed amount. But, the statutory rates represent a decreasing portion of the actual transport costs over time. Therefore, if producers absorbed the full transport charges, the average grain price received would have decreased more each year. Consequently, the average price received for grains and oilseeds has been supported above the level which would have prevailed if transportation market forces had not been restricted.

Returning to Figure 1 , to the producer, the reduced grain freight rate effectively increases the price from P to P′. Economic rent accruing to fixed factors may then be anticipated to increase to area ab. Therefore, the statutory rates can be expected to have increased the economic rent accruing to fixed factors, specifically land.

2.1.2 Technological Change

Economic rents can also be affected by alterations in costs. Since an individual farm faces a perfectly elastic demand for its crop, it is incapable of affecting total revenue through grain prices received. On the cost side, though, the firm influences the level of economic rents through the adoption of technical advances. Each grain farm combines many inputs to produce crops according to a certain level of technology. Through technological change, output increases for the same combination and level of inputs or different mix of inputs.[11]

Technical progress in agriculture[12] may be classified into:

1) 'land-saving' changes (biological innovations) and,

2) 'labour-saving' changes (mechanical innovations).

Biological technical progress in Prairie agriculture has been experienced primarily through the introduction of pesticides, genetically superior crops and fertilizers. Those innovations increase the yield potential of farm land. On the other hand, mechanical innovations facilitate the substitution of capital in the form of machinery for labour. Given the trend to larger farm sizes in the Prairie provinces, it would appear this substitution has occurred.

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[11] For a more detailed discussion of the influence of agricultural technical progress on land prices see:J.D.Dyck, "The Impact of Adopted Technological Change on Farmland Prices in Manitoba", unpublished M.Sc. thesis, Department of Agricultural Economics, University of Manitoba, 1979.

[12] E.O.Heady, "Basic Economic and Welfare Aspects of Farm Technological Advance" Journal of Farm Economics, 1949, p.296.

Consider, for example, a technical advance in agriculture. Returning to Figure 1 , a reduction in marginal cost because of the adoption of either biological or mechanical technologies shifts MC to MC′. Economic rent thus increases from area a to area acde. Combining the influence of such a technical change and a price support provided through the statutory rates, economic rents increase from area a to area abcdefg. Such above normal rents increase the rate of return on land investment, which plays a crucial role in the land investment decision making process.

2.2 LAND INVESTMENT ANALYSIS

2.2.1 Cash Land Purchases

Capital budgeting and investment analysis are financial procedures developed for evaluating investment decisions. Among the various criteria which may be used to examine investment alternatives, the internal-rate-of-return method is commonly used and accepted. That method is generally considered superior since it directly accounts for the time value of money.

The concept of the internal-rate-of-return (IRR) or the 'marginal efficiency of capital' is relatively simple. It is the rate of interest which equates the net present value of a projected series of cash flow payments to zero. In other words, the internal-rate-of-return equates the present value of the cash flow series to the initial investment, assuming the initial investment is a one shot injection. Using a land investment as an example, the IRR method may be mathematically depicted as follows:

$$0 = -P + \sum_{n=1}^{N} C(1+g)^{n}(1+r)^{-n} + P(1+a)^{N}(1+r)^{-N} \qquad (1)$$

or

$$P = \sum_{n=1}^{N} \frac{C(1+g)^{n}}{(1+r)^{n}} + \frac{P(1+a)^{N}}{(1+r)^{N}} \qquad (2)$$

where:

P = initial investment (price per acre),

C = expected annual net cash flow per acre,

g = expected annual increase in net cash flow per acre,

N = number of years in the planning horizon,

a = expected annual increase in land value, and

r = internal-rate-of-return to land.

This procedure allows for a ranking of investments according to their internal-rates-of-return. The investment yielding the largest rate-of-return will be preferred to all others. The decision to invest depends upon how the rate compares to the market rate of interest (the opportunity cost of capital). The final decision may still be subject to risk and liquidity considerations.

Any potential land investor is subject to a range of investment choices. This is especially so in the case of farmers who must also consider investments in machinery, buildings and livestock. The demand for land by any investor or firm may be identified by isolating and summing all potential land investments having a greater internal rate of return than the market rate of interest. Horizontal summation of all investors' demand schedules yields the aggregate demand for farm land.

2.2.2 Credit Land Purchases

Since land is seldom purchased on a strictly cash basis, consideration must be given to how the internal-rate-of-return of a land investment is affected by terms of credit. Given a budget constraint, the investor equates the net present value of the series of projected cash flow to the net present value of a series of annual mortgage payments. Extending equation 2 to incorporate the cost of credit, the IRR criteria becomes:

$$P = \frac{\sum_{n=1}^{N} \frac{C(1+g)^n}{(1+r)^n} + \frac{P(1+a)^N}{(1+r)^N}}{DP + (1-DP)\frac{[(1+r)^t-1]\,[i(1+i)^t]}{[r(1+r)^t]\,[(1+i)^t-1]}} \qquad (3)$$

where:

DP = percentage of downpayment required as purchase price,

i = nominal rate of interest charged on mortgage loans, and

t = length of mortgage.

Equation 3 may be altered so as to be interpreted in a present value context. If r is replaced by what the investor perceives to be an acceptable rate of return, P becomes the maximum price the investor is willing to bid in the market for the particular tract of land in question.

An investor's expectations of the annual cash flow per acre and its rate of growth are crucial in determining a maximum bid price. Invest-

ment theory suggests the historical levels of annual cash flow per acre should be important in accounting for movements in farm land prices. Dyck defined cash flow to be the difference between total crop receipts and total costs excluding payments to land, management and operator labour. Total annual receipts are dependent directly upon crop prices and yields as well as cropping rotations. The crop prices received by Prairie farmers are determined in world markets, less the costs for handling and transportation. Crop yields have been significantly increased by biological advances and expanded useage of agricultural chemicals. In most years, the additional revenue exceeded the incremental expenditures for increased biological and chemical useage and subsequently raised cash flow per cultivated acre.

Most investments in farm real estate from the agricultural sector originate from the family farm unit. The adoption of biological advances and the expanded useage of agriculture chemicals have an identical impact on crop cash flow whether on a per acre or on a per farm basis. But, crop cash flow levels have also been raised through the adoption of mechanical advances. The impact of this process has been increased capital investments and reduced labour requirements. Such advances have a different impact whether a per farm or a per acre basis is being considered. Therefore, if the farm unit is central to land investment analysis, it is the impacts of mechanical advances on crop cash flow levels on a per farm basis which are of interest. Romain[13] found the demand for farm machinery to be closely tied to the average

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[13] R.F.J.Romain, "Canadian Demand for Farm Machinery and Related Inputs," unpublished M.Sc. thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, Manitoba, February 1980.

level of investment funds per farm. On a per acre basis, the increased capital expenditures are more than offset by the increased productivity and decreased labour requirements they command. On a per farm basis, this positive impact on crop cash flow is increased further. Farm sizes have increased as labour requirements per acre declined. Therefore, on a per farm basis, with the decrease in the number of farms and assuming a marginal propensity to consume less than one, each farmer controls more investment funds.

An investor or farmer must estimate the expected cash flow from crop production upon which to determine a bid price for farm land. All components comprising the income stream must be considered as well as their expected movements in the future. Such expectations are likely to be highly affected by past experience. Because of the fluctuations, especially in crop yields and prices, past crop cash flow levels display a great deal of variability. A farmer will incorporate such changes provided they are of a permanent and not a transitory nature.[14]

2.2.3 Shifts in the IRR Schedule

Marginal analysis would suggest a profit maximizing investor or farmer should continue to invest in land until the internal-rate-of-return on the final investment equals the cost of credit for the investment. Returning to Equation 3, any changes in the estimation of the variables will change the value of the internal-rate-of-return. This may result in a change in the ranking of investments and, in turn, shift

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[14] R.J.Foote, Analytical Tools for Studying Demand and Price Structures, USDA, Agriculture Handbook No. 146, Washington, D.C., August, 1958.

the IRR schedule for land investments.

Statutory freight rates may be viewed as a subsidy on grain shipped from the Prairie provinces and, as such, augment farm cash receipts. Because of the permanent nature of these rates, crop cash flow levels related to farm land likely have been perceived by investors to continue at this historical level. Consequently, the increased expected annual crop cash flow created by the statutory rates would be anticipated to create an outward shift in the aggregate demand for land. Investors would no longer be in a profit maximizing position and would prefer to increase their land purchases. But, farm land is of limited supply. Consequently, investors bidding for this limited supply of land inflate land prices. Farm land prices continue to rise until the rate of return is restored to a level received prior to the implementation of the statutory rates. That is, the IRR schedule shifts back to its original equilibrium position. Therefore, the increase in crop cash flow levels from farm land resulting from the statutory rates may be anticipated to have increased farm land prices to the point where the benefits from the statutory rates become capitalized into farm land prices.

2.3 RELATED STUDIES

Pope et al[15] reviewed many of the empirical models developed by agricultural economists dealing with the U.S. farm land market. The study emphasized the ability of the models to account for the escalation of farm land prices in the 1970's. The performance of three of the best

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[15] R.Pope, R.Kramer, R.Green and D.Gardner, "An Evaluation of Econometric Models of U.S. Farmland Prices", WJAE, Vol.4, No.1, July, 1979.

known simultaneous models was examined when they were re-estimated with more recent data. The model developed by Herdt and Cochrane[16] provided the best forecasting performance. A supply, demand and identity equations for the farm land real estate market were included in the model. The endogenous variables in the system were the acres of farm land sold each year, as well as, the price level. The supply equation included returns from non farm investments, unemployment rates and the amount of land in agriculture as exogenous variables. Demand for farm land was hypothesized to be dependent upon prices for farm products, agricultural productivity, inflation rate of the economy and capital gains in farm land. The model was re-estimated using recent data. The results showed many of the variables to be insignificant with the exception of the amount of land in agriculture, technology and the lagged price structure. The forecasts were less accurate than the estimates from a naive time series model (Box-Jenkins). The single equation structure estimated by Klinefelter provided the most accurate prediction of all the models reviewed. The Klinfelter model expressed the price of farm land as a function of average farm size, net income, number of transfers, expected capital gains and a price index for gross national product. When the Klinefelter model was re-estimated using more recent data, the sign on average farm size and transfers changed. A three-year moving average of farm land prices was used to derive the expected capital gains variable thus incorporating lagged values of the farm land price. The review of the various models concluded the specifications were not capable to accurately reflect relevant structural changes and other

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[16] R.W.Herdt, and W.W.Cochrane, "Farmland Prices and Technological Advance", Journal of Farm Economics, Vol.48, 1966.

characteristics of the farm land market. Thus, additional research into how expectations are formulated by land market participants is required if the concern of such models is predictive ability as well as economic structure.

Canadian studies on the farm land market have mostly been concerned with cross-sectional examination of price differences between regions.[17] Studies by Roehle,[18] Kraft[19] and Dyck[20] concentrated upon explaining movements in farm land prices over time using ordinary-least-squares single equation specifications.

Roehle examined farm land prices between 1928 and 1969. The receipts from the sale of crops in the previous years, changes in these receipts between the two previous years and a trend were included as determinants. The model was extended by Kraft to include the annual loans disbursed for farm mortgages. Predictions within and outside the period of estimation were satisfactory with both models. However, the models

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[17] Examples of three such cross-sectional studies of the farm land market are: S.H.Barber, Farm Land Prices in Saskatchewan, Economics and Statistics Branch, Saskatchewan Department of Agriculture; J.O.Magnusson, "The Influence of Non-Resident Investment on Farm Land Prices in Manitoba and Saskatchewan," unpublished M.Sc. thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, 1979; and V.W.Ruttan, "The Impact of Local Population Pressure on Farm Real Estate Values in California", Land Economics, Vol.37, No.2, May 1961, pp.125-131.

[18] R.G.Roehle, "An Econometric Analysis of Farmland Values in Western Canada", unpublished M.Sc. thesis, Department of Agricultural Economics, University of Manitoba, 1971.

[19] D.F.Kraft, What's Land Worth Now, Occasional Serie #6, Department of Agricultural Economics, University of Manitoba, 1974.

[20] J.D.Dyck, "The Impact of Adopted Technological Change on Farmland Prices in Manitoba", unpublished M.Sc. thesis, Department of Agricultural Economics, University of Manitoba, 1979.

posed certain problems which were difficult to explain and/or justify. The sign on the change in crop receipts was negative, the factors underlying the trend were not apparent and the disbursement of mortgages was probably related to the level of sales.

Dyck's model specified the price of farm land to be a function of the maximum bid price of land, the average price of land in the previous year and an expectations variable given by the stock of grain on farm. Crop production per acre was estimated through forecasting crop yields as a function of fertilizer use, crop varieties, crop rotation and average weather conditions. An expected net income per acre was determined using crop prices and expenditures for all inputs except land and management. A maximum bid price was determined from 1961 to 1976. Estimation procedures found the maximum bid price variable to be problematic and the inventory variable insignificant. The difficulties encountered in this specification were attributed to credit constraints in effect from the early to later 1960's. Removal of the terms of credit from the maximum bid price of land left lagged net income as an explanatory variable. The final specification expressed the average price of farm land as a function of the net income per acre in the previous year and the lagged price of farm land.

Harris and Nehring[21] examined the relationship between farm size and the bidding potential for agricultural land. Their study attempted to determine if the recent trend to larger farming units could be accounted for by a greater bidding potential on the part of the larger farms. A

[21] D.G.Harris and R.F.Nehring, "Impact of Farm Size on the Bidding Potential for Agricultural Land", AJAE, Vol.58, No.2, May 1976.

theoretical maximum bid-price model was developed to determine those variables affecting the bidding potential. From the maximum bid-price model, the impacts of various sets of characteristics, capabilities and expectations of farming units could be examined. A numerical specification of the parameters and variables in the model was estimated for various size categories of cash-grain farms in Iowa. Although data limitations and necessary assumptions were a drawback to the numerical analysis, the conclusions did point to the importance of economies of size in the growth of farming units. The analysis demonstrated larger farms had a greater bidding potential than smaller farms but, the largest farms do not necessarily have the greatest advantage.

2.4 SUMMARY

The working hypothesis is that statutory freight rates have increased farm land prices in the Prairie provinces. This hypothesis has been developed in this chapter by examining the theoretical aspects of the economic rents earned by farm land. In addition, the impacts of technological change, as well as, the statutory freight rates on those rents were examined. Investment theory suggests the historical levels of expected annual crop cash flow payments from land should reflect movements in farm land prices. Therefore, identification of an appropriate expected crop cash flow stream is crucial to the analysis. Since most investments in farm real estate originate from the family farm unit, expected crop cash flow on a per farm basis is considered the appropriate unit of measure. Empirical models of the farm land market reveal single equation specifications are generally as good as simultaneous

specifications. The final specification developed by Dyck expressing the average price of farm land as a function of the net income per acre in the previous year and the lagged price of farm land proved to be adequate to simulate land prices by crop district in Manitoba. Considering the similarity of the agriculture industry in the Prairie province, this specification should also be appropriate to explain farm land prices in Saskatchewan and Alberta.

Chapter III

ANALYTICAL MODEL, SIMULATION PROCEDURES, AND DATA

The basic analytical model incorporated into the analysis is a land price model. This model specifies the established relationship between farm land prices and expected crop cash flow levels. Formulation of expected crop cash flow levels is central to this model. Its development requires information on crop yields, crop rotations, input useage and transportation rates charged. Various models and procedures are adopted to determine these factors. The land price model is then used to provide for simulations of the farm land market over the historical time period from 1961 to 1979, as well as, to simulate levels from 1980 to 1990. All models are first specified and the procedures adopted for the various simulations of the farm land market are examined. Finally, data definitions and sources are discussed.

3.1 LAND PRICE MODEL

A positive relationship is hypothesized to exist between farm land prices and expected crop cash flow levels. It is assumed this relationship is not of a fixed proportion but, as follows:

$$P = R^{\alpha} \tag{4}$$

where:

P = price of farm land ($/acre), and

R = expected crop cash flow ($/farm).

But, expectations on crop cash flow may also be affected by crop cash flow levels in previous years, and where the more recent years would have the greatest influence. Therefore, previous crop cash flow levels are included by applying geometrically declining weights. The following equation gives this relationship when lambda (λ) represents the weighting factor applied to previous crop cash flow levels.

$$P_0 = (R_0 * R_{-1}^{\lambda} * R_{-2}^{\lambda^2} * \ldots * R_{-n}^{\lambda^n})^{\alpha(1-\lambda)} \quad (5)$$

But,

$$P_{-1} = (R_{-1} * R_{-2}^{\lambda} * R_{-3}^{\lambda^2} * \ldots * R_{-n}^{\lambda^n})^{\alpha(1-\lambda)} \quad (6)$$

Multiplying both sides of 6 by λ and dividing 5 by 6 gives:

$$P_0 = R_0^{\alpha(1-\lambda)} * P_{-1}^{\lambda} \quad (7)$$

Equation 7 is estimated as follows:

$$P_0 = a0 * R_0^{a1} * P_{-1}^{a2} * e \quad (8)$$

where:

$a1 = \alpha(1-\lambda)$, and

$a2 = \alpha$.

This land price model implies the price of farm land in the current year is a function of the expected crop cash flow in the current year, the average price of land in the previous year, and an error term.

Equation 7 is characterized by constant elasticities. The short run elasticities are directly measured by the regression coefficients. The elasticity of land price with repect to cash flow is measured by a1 while the elasticity of land price with respect to its lagged value is measured by a2. These values give the percentage change in the price of land which may be expected, in the short run, from a one percent change in either last year's price or crop cash flow.

In simulating future land prices, it is the long run elasticity of the function which is of importance. This elasticity is expressed in Equation 7 by α. That is, α expresses the percentage change in the price of land which can be expected, in the long run, from a one percent change in crop cash flow. It is expected this elasticity should approach one. That is, the long run equilibrium land price should appreciate at the same rate as crop cash flow. This implies $\alpha = 1$ or $a1 + a2 = 1$. This should hold for the farm land market provided no other higher valued uses influence the price in the future. This long run elasticity is calculated from the regression coefficients as follows:

$$\alpha = \frac{a1}{1 - a2} \tag{9}$$

In the long run, the price of land may be considered equal to its lagged value ($P_0 = P_{-1}$). Therefore, from Equation 8, the long run equilibrium price of land becomes:

$$P_0 = a0^{\frac{1}{1-a2}} * R_0^{\frac{a1}{1-a2}} * e \tag{10}$$

3.2 CROP CASH FLOW MODEL

It has been established movements in farm land prices may be accounted for by expected annual crop cash flow levels. Expected crop cash flow is expressed as follows:

$$ECF = (ER - VC)/FARMS \tag{11}$$

$$ER = EY * EP * ACRES \tag{12}$$

$$EY = intercept * V * F * (average\ weather\ impact) \tag{13}$$

$$EP = IP + FP(-1) \tag{14}$$

where:

ECF = expected crop cash flow per farm ($/farm),

ER = expected crop receipts ($),

VC = crop variable costs ($),

FARMS = total number of farms,

EY = expected yield (bu./acre),

EP = expected price ($/bu.),

ACRES = acreage seeded to the specific crop,

V = genetic potential index (base=1),

F = combined fertilizer applications rate (lbs./acre),

IP = inital price ($/bu.), and

FP = final payment ($/bu.).

Expected crop receipts are influenced by the expected yield and price levels for each crop. The expected yields on stubble and fallow land for each crop are determined from the crop yield model. The yield levels expected depend upon types and levels of inputs used under normal weather conditions. Prices for crops marketed through the Canadian Wheat Board (wheat, oats, barley) consist of an initial and final payment. In any year, a producer's expectation of those prices is assumed to consist of the initial price plus some expectation on final payments. Since expectations are influenced by past experience, expected prices of the Wheat Board grains are calculated as the sum of the initial price in the current year and the final price received in the previous year. For non-Board oilseeds (rapeseed and flaxseed) only one payment is received when the crop is sold. Expectations for oilseeds are thus taken to be the average price received in the previous year. Annual total summerfallow and crop land acreages are taken as they occurred. From this information, total crops seeded to stubble and fallow land are calculated in any year. The five principal crops are taken to be representative of all crops grown in the Prairie provinces. The distribution between these five crops on stubble and fallow is taken as occurred and, combined with total crop land acreages on stubble and fallow. In this manner, total crop acreages seeded to stubble and fallow land are distributed across the five principal crops.

Since the average farm land price includes hay and pasture land as well as crop land, expected receipts from land are expanded to include returns from hay and pasture. To include an expected value of hay and pasture, actual hay prices in the previous year and, average hay yields lagged one year are used. To account for pasture, the expected value of hay is doubled.

Equation 11 in the expected crop cash flow model shows the expected production of all crops receive a price equivalent to the export market. A closer examination of this assumption is required to gain a better understanding of the implications. Not all production of the principal crops in the Prairie provinces flows into the export and eastern domestic market. A certain share is consumed by livestock within the Prairies. Feed grain prices paid by Prairie livestock producers are artificially higher because of the statutory rates whenever livestock producers must compete with the export market to obtain adequate supplies. On occassions when Prairie grain supplies expand more rapidly than export sales, a temporary accumulation of grain stocks has caused the difference between feed grain and export prices to widen. Therefore, the assumption of using export prices to determine expected crop cash flow may be misleading during periods of rising grain stocks. Consequently, during such time periods, expected crop cash flow levels specified in the model overestimate a land investor's outlook. The consequence of the assumption may be an overestimation of farm land prices in the event land prices are sensitive to downswings in realized crop cash flow levels because of accumulation of grain supplies.

3.2.1 Crop Yield Model

Because of year-to-year variations in crop yields due to weather conditions, a transitory element exists in actual crop yield data. Expectations on crop yields require a measurement of some anticipated permanent level of yields. A crop yield model similar to the one developed by Dyck[22] is used. The crops considered are the five principal ones (wheat, oats, barley, rapeseed and flaxseed) grown in the Prairie provinces. Each crop is divided into stubble and fallow production to remove the influence of changing cropping patterns on average crop yields. Provincial annual data from 1961 to 1978 is used for Saskatchewan and Alberta. Since annual observations are available for each of the fourteen crop districts in Manitoba from 1961 to 1976, a pooling of these observations is used for this province.

Three factors are considered to account for the year-to-year variation in provincial yields. They include the fertilizer application rate, variety of crop seeded and soil moisture levels at different times in the growing season. The stubble and fallow yields for each crop are specified as in Equation 15 and, are estimated using ordinary least squares. In this manner, the statistical equations so specified determine the influence of technology and moisture levels on provincial crop yields.

$$Y = b0 * V^{b1} * F^{b2} * DM1^{b3} * DM2^{b4} * e \qquad (15)$$

where:

[22] J.D.Dyck, op.cit.

Y = yield per acre of each crop on fallow or stubble land,

V = genetic potential index for the crop grown,

F = combined application rate of nitrogen and phosphorous,

DM1 = soil moisture deficit during the first 60 days of growth, and

DM2 = soil moisture deficit during the last 30 days of growth.

A multiplicative specification is specified because of the interdependence among the independent variables in determining crop yields. Since variable V measures the actual genetic potential index for the crop grown, there is no reason to suppose the regression coefficient would be different than one. Therefore, estimations are performed with the coefficient b1 restricted to one.

The crop yield model, as specified, utilized aggregate data available on a provincial basis for Saskatchewan and Alberta. Since data on a crop district basis is available for Manitoba, alterations to the crop yield model, as specified, are required. The model is expanded to include additional soil moisture variables which are available by crop district. The stubble and fallow yields are estimated in Manitoba for each crop from the specification given in Equation 16.

$$Y = b0 * CD^{b5} * V^{b1} * F^{b2} * DM1^{b3} * DM2^{b4} * e^{EM1} * e^{EM2} * v \qquad (16)$$

where:

CD = a series of dummy variables identifying the crop district from which any given set of observations are originating,

EM1 = number of days when the soil moisture exceeded the holding capacity during the first 30 days of growth, and

EM2 = number of days when the soil moisture exceeded the holding capacity during the 31st and 60th day of growth.

Since potential yield levels vary by crop distict, a series of dummy variables are incorporated. Crop district 14 is chosen as the base and therefore, the intercept b0 represents the intercept value for that crop district. All other crop districts have an intercept value of b0 times the coefficient on the dummy variable identifying the crop district as the source of the particular observations.

3.2.2 Fallow/Stubble Acreage Model

A fallow/stubble acreage model is specified to forecast acreage levels. Total land seeded to crop production increased throughout the 1960's. This growth in crop land occurred not only as a result of additional land cleared and cultivated but, largely because less land was summerfallowed. Of the total cultivated acreage, the amount summerfallowed in the previous year will be sown to crop in the current year. A producer must then decide between seeding or summerfallowing the land cropped in the previous year. Over the period of observations, the Prairie provinces steadily decreased the ratio of the acreage summerfallowed to seeded crop. This decrease was brought to an abrupt halt by the LIFT program in 1970 which paid farmers not to seed land to wheat.

A linear specification (Equation 17) is used to demonstrate the change in the fallow/stubble crop ratio over time. The total acreage on which this decision is based is hypothesized to be a function of the total acreage seeded to crop in the previous year plus a constant increase (Equation 18). A variable for the LIFT program is incorporated to account for the abnormal levels of summerfallow in 1970. In fact, in Saskatchewan more land was fallowed than cropped in 1970. Using annual provincial observations from 1961 to 1979, the parameters on the following set of linear equations are estimated using ordinary least squares.[23]

$$ASUM/AS = c0 + c1*TIME + c2*LIFT1 + c3*LIFT2 + e \quad (17)$$

$$AC = d0 + d1*AC(-1) + d2*LIFT1 + d3*LIFT2 + e \quad (18)$$

where:

AS = acreage seeded to stubble land,

ASUM = summerfallow acreage,

AC = acreage in crop [AC = AS + ASUM(-1)],

TIME = year,

LIFT1 = dummy variable to account for the LIFT program, and

LIFT2 = dummy variable to account for the lagged effect of the LIFT program.

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[23]This set of linear equations should technically have been estimated using the Zellner estimation for efficient estimation of a seemingly unrelated equations model. These equations are linked because of the correlation between the error terms. Independent ordinary least squares equation estimation would yield consistent and unbiased parameter estimates. But, the efficiency of the parameter estimates could be improved using the Zellner estimation. However, its small sample properties are not well known.

Given the statistical relationships provided by this model, crop land acreages seeded to stubble and fallow land are determined using Equations 19 and 20.

$$AS = [(ASUM/AS)+1]^{-1} * AC \quad (19)$$

$$ASUM = [(ASUM/AS)^{-1} +1]^{-1} * AC \quad (20)$$

3.2.3 Fertilizer Application Rate Model

A fertilizer application rate model is derived to forecast application rates. Fertilizer use has increased tremendously during the 1970's. In 1979, Prairie farmers, on average, were applying between three and four times the plant nutrients used in 1970. A trend variable is specified to reflect the steady growth in fertilizer use. Variations from this trend are hypothesized to be related to the relative prices of grain and fertilizer. A linear equation is specified and estimated using ordinary least squares for fertilizer application rate for each crop grown on both stubble and fallow land. In general, the equations are specified as follows:

$$F = e0 + e1*(PGRAIN/PIF) + e2*TIME + e \quad (21)$$

where:

F = fertilizer application rate (lbs./acre),

PGRAIN = price received for the particular crop ($/bu.),

PIF = price index of fertilizer (1971=100), and

TIME = year.

3.2.4 Grain Freight Rate Model

Crop cash flow levels are influenced by grain freight rates since the rates charged affect farm prices. Grain freight rates have been fixed historically. In order to determine what crop cash flow levels would have been under compensatory rates, an indexing procedure is adopted to adjust the statutory rates. Benchmark values of 2.74 and 3.08[24] are available for 1974 and 1977, respectively, and reflect the levels the statutory freight rates would have to increase by to become compensatory. An indexing procedure is developed to derive a time series of compensatory levels prior to those years. In the 1977 study by Snavely et.al.,[25] a cost comparison between 1974 and 1977 is provided for both Canadian National and Canadian Pacific Rail. From this, aggregate cost categories are determined for both railways. Costs for Northern Alberta Railway are then distributed across these categories in the same proportion. The categories cover such items as repair and servicing, road maintenance, fuels, property taxes and labour. Appropriate price indexes are applied to the cost categories over the period of observations from 1961 to 1979. In this manner, two time series of costs are derived for railway costs. One series applies to the 1974 cost base and the other to the 1977 cost base. The time series are transformed into indexes with the base year set equal to one. The 1974 index is multiplied by 2.75 and the 1977 index by 3.08. This gives two sets of time series representing the amount the statutory rates would have to rise by to be compensatory. The forces of inflation over the period from 1974

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[24] Snavely, King and Associates, op.cit.

[25] Ibid.

to 1977 were circumvented to a considerable extent by increased efficiency in the railways' operations and government expenditures for additional hopper cars. In order to account for this change, the final time series is derived in the following manner:

1961 to 1974: 1974 series,

1975 to 1976: average of the two series, and

1977 to 1979: 1977 series.

Continuing from a previous discussion on the demand for Prairie grain from within and outside the Prairie provinces, the assumption of using only one grain price becomes more realistic once compensatory rates are charged. The allocation of grain between these two markets is distorted by the statutory rates in favour of the eastern and export markets. In order to compete for limited supplies, the Prairie feed grain buyer is often forced to pay higher prices. Once compensatory rates are charged however, the Prairie feed market should no longer have to pay higher prices. Therefore, assuming only one feed grain price does not likely hinder the estimation of movements in expected crop cash flow levels when compensatory rates are charged.

3.3 HISTORICAL SIMULATIONS

Given the statistical relationship provided by the land price model (Equation 8), the influence of the statutory freight rates on farm land prices in the Prairie provinces are determined through a simulation procedure. A schematic diagram of the linkages between the models developed to perform the simulation is presented in Figure 2 .

A benchmark simulation involves the estimation of farm land prices by province as experienced. This involves incorporating crop prices, technological changes and transportation rates as they occurred. Given an initial price in 1960, land prices from 1961 to 1979 are simulated using a recursive system employing expected crop cash flow levels in each year. The expected crop cash flow values are based upon expected annual yields and expected prices with the varietal distributions, fertilizer input levels and cropping patterns as they actually occurred. These simulated benchmark farm land prices should closely track actual prices.

A second simulation of land prices is derived once the grain freight rates are adjusted. The transportation rates on grains and oilseeds in each province are increased by an amount whereby they would be compensatory. Expected prices are then decreased according to the newly calculated transportation rates. A comparison of the two historical simulations allows for an estimation of the influence of the statutory rates on farm land prices.

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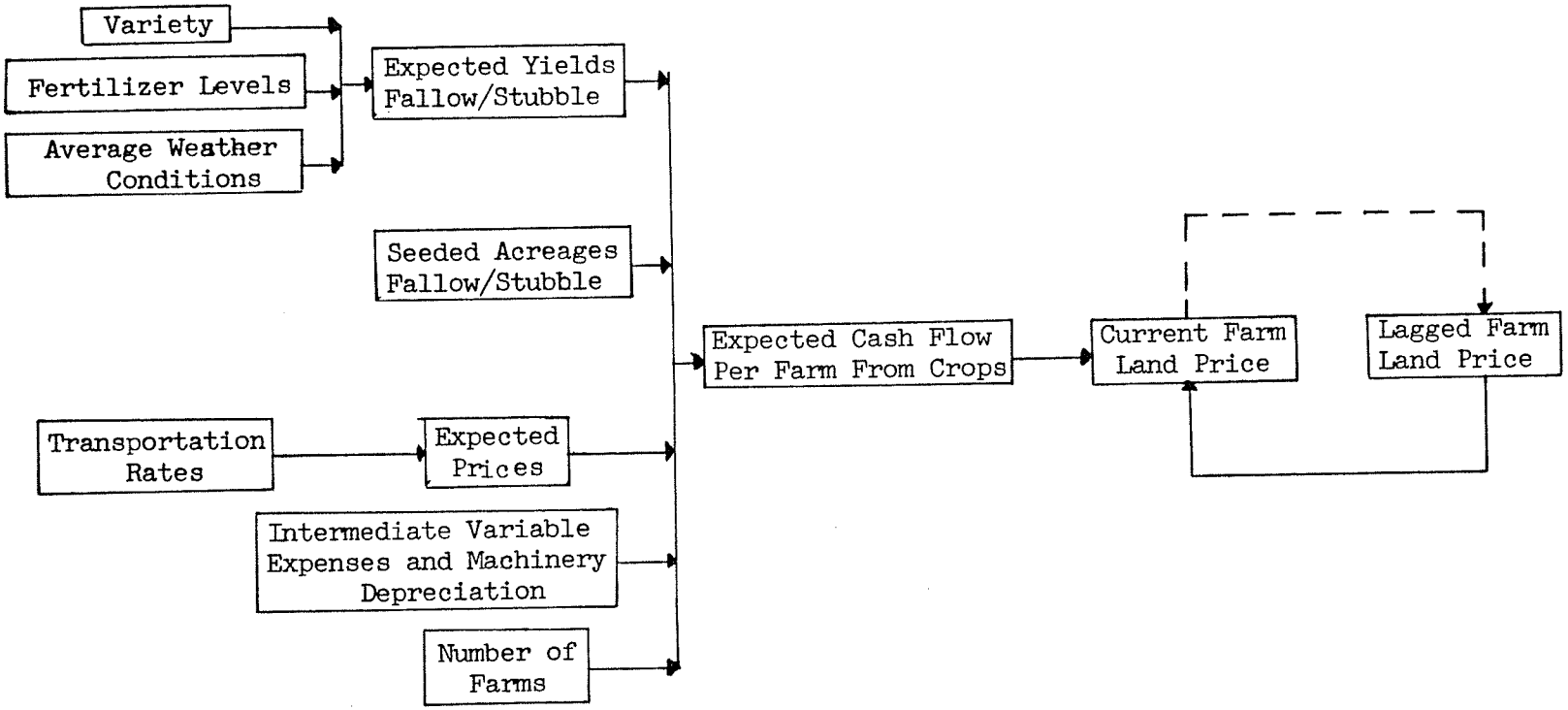


Figure 2

Schematic Diagram of Model Linkages Used
in Simulating Farm Land Prices

3.4 FUTURE SIMULATIONS

Three ten-year simulations of future land prices for the Prairie provinces are developed from the aforementioned models. The simulations differ only in terms of the transportation rates charged for shipping grains and oilseeds. The rate structure is altered according to three assumptions regarding future transportation charges. First, projected land prices are simulated assuming the statutory freight rates are maintained at their present level. Secondly, producers receive the 'crow benefit', namely the difference between the present rates and those required to be compensatory in 1980. The producers are then assumed to pay any additional increases in future grain freight costs. It is assumed the freight rates rise at a compound rate of 11 percent per annum.[26] Finally, producers are required to absorb the full compensatory transportation costs and, these costs are expected to increase at a compound rate of 11 percent per annum.

The variety improvement indexes and the crop share distribution are assumed to be maintained at the 1979 levels. Projected levels of stubble/fallow seeded acreages, summerfallow acreages, fertilizer application rates and stubble and fallow yield levels are then determined from the models developed. Expected grain prices are assumed to increase at a compound rate of ten percent per annum. Studies on projected world food demands and supplies of agricultural products reveal there will be continued pressure on supplies to meet increasing world food demands.[27]

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[26] This alternative rate structure is examined in: R.M.Sokal, "The Economic Effects Of An Alternative To The Statutory Grain Freight Rates," unpublished M.Sc. thesis, Department of Agricultural Economics, University of Manitoba, Winnipeg, Manitoba, July 1980.

Consequently, the assumption of expected grain prices increasing at a compound rate of ten percent per annum is conservative since this was the rate of increase over the 1970's. Expected prices are then reduced according to the projected level of grain freight rates being examined. Operating costs as well as hay prices are also assumed to increase at a compound rate of ten percent per annum as this is representative of the rate of increase over the 1970's. An average level of hay yields and acreages from 1975 to 1979 are used. Total farm land acreage is maintained at the 1979 level. Average farm size is assumed to continue to increase at the rate experienced from 1971 to 1979. Real machinery depreciation is maintained at the 1979 level while machinery prices are increased at a compound rate of ten percent per annum.

With this information, projected levels of expected crop cash flow per farm are determined under the three assumptions regarding future grain freight charges. Given a 1979 land price, the land price model simulates future land prices. A comparison of these simulations indicates the future impacts on land prices because of adjustments to the statutory rates.

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[27] The following publications provide discussion on projections of world food demands and supplies: FAO, FAO Commodity Projections 1985 Cereals: Supply, Demand and Trade Projections 1985, prepared by the Commodities and Trade Division Economic and Social Policy Department, Rome; Ministry of Agriculture and Forestry, Outline of the World Food Model and the Projections of Agricultural Products for 1980, 1985 Japan, August 1974; and United States Department of Agriculture, Alternative Futures for World Food in 1985, Volume 1, World GOL Model Analytical Report, Department of Agriculture, Economics, Statistics, and Cooperative Services, Washington, D.C., 1978.

3.5 DATA

3.5.1 Crop Yields

Annual crop yields on stubble and fallow by crop district in Manitoba are taken from unpublished Statistics Canada worksheets made available by the Manitoba Agricultural Statistician. Crop yields provided by the Manitoba Crop Insurance Corporation are used as long as more than 2000 acres are seeded to the crop. Provincial crop yields levels on stubble and fallow are taken as reported in Statistics Canada: Field Crop Reporting Series (cat.no.22-002).

3.5.2 Fertilizer Application Rates

Fertilizer application rates for stubble and fallow crops are determined from questionnaires completed by clients of the Manitoba Crop Insurance Corporation (MCIC). All clients reported application rates of nitrogen and phosphorous on each crop, the type of seedbed and the resulting yield. The average crop district application rates are adjusted by the ratio of the estimated provincial useage to actual provincial sales reported by Statistics Canada: Fertilizer Trade, (cat.no. 46-207). Because of the limited number of observations before 1965, total provincial sales in these earlier years are distributed across crop districts and crops in the manner experienced in the more recent years. In this way, the pounds of nitrogen and phosphorous applied per acre are estimated for each crop in each crop district for both stubble and fallow seedbed. Application rates for the province of Manitoba are determined from an aggregation of the crop district data.

Crop insurance records were not obtained from Saskatchewan or Alberta. Assuming Prairie farmers apply the same ratio of nitrogen and phosphorous to each crop, fertilizer useage in Alberta and Saskatchewan are determined by using the relative rates for Manitoba as a base. The absolute levels applied to each crop in Saskatchewan and Alberta then depends upon total nutrient sales. In this manner, year-to-year variations in nutrient sales are incorporated into the application rates for each crop. Observations for total nutrient sales from 1961 to 1977 are taken from Statistics Canada: Fertilizer Trade. This publication was discontinued in 1977. More recent data is taken from the Canadian Fertilizer Institute: Western Canada Fertilizer Association Retail Sales.

3.5.3 Varietal Improvement Index

The index measuring the genetic potential of the crops seeded was developed by Dyck.[28] The procedure involved a comparison of the average yield of each crop variety over the years tested in the Cooperative Trials to the yield of a benchmark variety tested over the entire period of interest. The benchmark variety was assigned a weight of one while the other varieties were assigned weights relative to the benchmark variety. The variety weightings were then multiplied by the proportion of the crop sown to the variety each year. The index reflects the expected effect higher yielding varieties would have on crop yield in the province over time. This interpretation assumes the relative differences between varietal yields are constant across the Prairie provinces.

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[28] J.D.Dyck, op.cit.

3.5.4 Soil Moisture Levels

Soil moisture levels at different times in the growing season are considered critical for optimum plant growth and maximum yields. Estimations of the variables included to account for soil moisture levels were developed by Dyck.[29] A soil moisture shortfall is defined to occur anytime a crop's daily consumptive requirements are not met. Two variables are included to account for the differential impact on crop yields caused by the timing of the shortfall. The growing season is subdivided into two intervals, the first 60 days and the 61st to the 90th day. The daily soil moisture shortfalls are then summed over each period to provide two indicators of the moisture conditions for each year in the analysis. The exact same procedure is adopted to provide measurements for these variables in Saskatchewan and Alberta.

Events of excess precipitation are defined to occur whenever the daily soil moisture exceeds 8 inches per acre, the assumed moisture holding capacity of the soil. For the purposes of this study, soil moisture levels in excess of 8 inches per acre represent an excess precipitation event. The growing season is subdivided into two intervals (seeding date to 30 days and 31st to 60th day) and the number of excess precipitation events are recorded for each interval.

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[29] J.D.Dyck, op.cit.

3.5.5 Average Farm Land Prices

Average farm land prices for the three Prairie provinces are obtained from Statistics Canada: Agriculture Division, Value of Farm Land and Buildings Survey. These prices also include the value of buildings.

3.5.6 Expected Cash Flow per Farm

Calculation of the annual expected cash flow per farm requires data for a number of variables.[30] The annual estimated acreages seeded to a crop as well as summerfallow and hay acreages are taken from Statistics Canada: Quarterly Bulletin of Agricultural Statistics (cat.no. 21-003). Acreage of crop land seeded on fallow in any year is equal to the acreage of summerfallow in the previous year. Acreage of crop land seeded on stubble is then taken as the difference between total crop land acreage and summerfallow acreage in the previous year. The annual proportion of acreages seeded to the five principal crops on stubble and fallow land is derived from acreages obtained from Statistics Canada: Field Crop Reporting Series.

Initial prices, F.O.B. Thunder Bay, and final prices for wheat, oats and barley are calculated from the Canadian Wheat Board Annual Reports. The initial prices are adjusted for average elevation charges as given by the Board of Grain Commissioners Annual Reports, and average transportion charges as given by Statistics Canada: Grain Trade of Canada (cat.no. 22-201) for each of the three provinces. Average annual prices for flaxseed and rapeseed in Manitoba are taken from the Manitoba Agricultural Yearbooks. Average annual prices for flaxseed and rapeseed in

[30] See Appendix A for data used in the analysis.

Manitoba are decreased by the differences in transportation charges to determine average prices for Saskatchewan and Alberta. Tame hay prices and yields are taken from Statistics Canada: Quarterly Bulletin of Agricultural Statistics.

Intermediate variable expense data came from Statistics Canada: Farm Net Income (cat.no. 21-202). Total annual provincial operating expenses included the summation of the following cost categories: taxes, wages, total machinery expenses, fertilizer and lime expenditures, other crop expenses, repairs to buildings, interest and other miscellaneous expenses. The total provincial depreciation on machinery is available from the same publication.

Estimates of average farm size are available on a provincial basis from Statistics Canada: Census of Canada, Agriculture. Farm sizes for 1979 are available from Statistics Canada: Agriculture Statistics Division, Farm and Agriculture Enumerative Surveys, (cat.no. 11-001).

3.5.7 Indexes

The procedure developed to derive a time series of compensatory rate levels requires the use of several price indexes. These indicies are applied to the railway cost categories.[31] The Statistics Canada: Farm Input Price Index (cat.no. 62-004) for repairs and servicing machinery and for property taxes are applied to these cost categories. The 'machinery repairs for Canada' and the 'property taxes for western Canada' are used for these purposes. Road maintainence is assigned the

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[31] See Appendix A for data used in the analysis.

'Canada granular base course' index obtained in the 'highway construction price' index given in Statistics Canada: Construction Price Statistics (cat.no. 62-007). Locomotive fuels are assigned the 'diesel fuel' index given in the 'petroluem and coal products industries' index in Statistics Canada: Industry Selling Price Index (cat.no. 62-011). Labour expenses are indexed according to the 'average weekly wages and salaries' obtained in Statistics Canada: Railway Transport (cat.no. 72-504). Losses and damages are indexed according to the average initial price of wheat. All other costs are indexed by the 'total general wholesale price index for Canada' given in Statistics Canada: Industry Selling Price Index.

Chapter IV

EMPIRICAL RESULTS AND DISCUSSION

This chapter examines the empirical relationships estimated for the models specified in Chapter III. Based on these relationships, farm land prices are simulated over the period of analysis. The simulated impact statutory rates have on farm land prices is then examined. Several implications of the capitalization of the statutory rates into farm land prices are examined. Finally, projected farm land prices are simulated under various assumptions regarding future grain freight rates.

4.1 CROP CASH FLOW MODEL

Formulation of expected crop cash flow levels per farm is central to the estimation of the land price model. These values for the Prairie provinces, estimated in the manner described in Chapter III, are presented in Table 2. A comparison of the values is more easily examined when they are graphed, as in Figure 3. Over the period of analysis from 1961 to 1979, Saskatchewan has the highest expected crop cash flow levels per farm. The levels in Manitoba and Alberta are more comparable to each other. Over the sixties, Alberta generally had the higher level but, Manitoba tended to exceed it during the seventies. The movements of expected crop cash flow in all provinces exhibit the same pattern. Levels were generally stable from 1961 to 1972 although, they all exhibited a small surge in 1967 and trough in 1969 to 1970. Over the entire

TABLE 2

Expected Crop Cash Flow per Farm in the Prairie Provinces

Year	Manitoba ($/farm)	Saskatchewan ($/farm)	Alberta ($/farm)
1961	2547	4270	2884
1962	2373	4228	3440
1963	2928	4878	3668
1964	3000	5397	3545
1965	2834	5243	3744
1966	3031	5912	4150
1967	4574	7618	4880
1968	2496	4045	2476
1969	1016	2509	1724
1970	1183	1739	1127
1971	2719	4969	3302
1972	3051	4818	2926
1973	15772	22239	15049
1974	18104	25518	17344
1975	18396	26434	17743
1976	10964	13421	9736
1977	8858	13046	9296
1978	8744	14791	10689
1979	11967	18287	11075

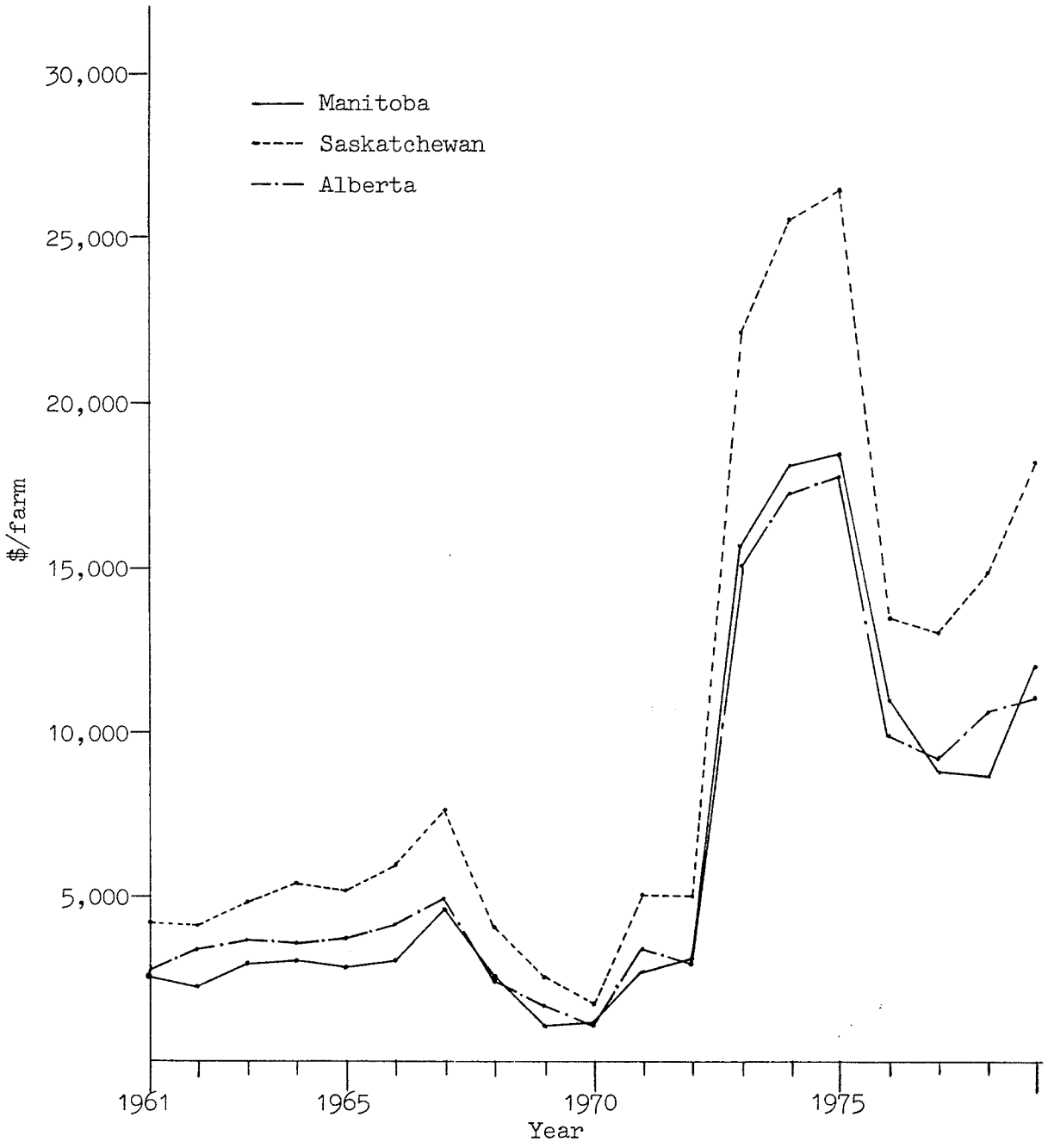


Figure 3

Expected Cash Flow per Farm
in the Prairie Provinces

period, levels in 1969 to 1970 in all three provinces were the lowest experienced. A large upswing occurred in 1973 following the crop failure in the Soviet Union and climbed gradually for the next two years before falling off in 1976. Levels in 1976 generally fell about one-half the increase experienced from 1973 to 1975. A gradual decline was again experienced in 1977, as well as, 1978 in Manitoba. The values increased for both Alberta and Saskatchewan in 1978. Levels rose for all three provinces in 1979.

To account for these movements in expected crop cash flow per farm, a closer examination of its components is required. Average farm sizes in all three provinces have increased very gradually from 1961 to 1979 and, therefore, cannot account for fluctuations in expected crop cash flow levels per farm. The remaining two components are receipts and costs.

Expected receipts from crops are linked to expected yields, cropping patterns and expected prices. Expected yields increased substantially from 1961 to 1979 in all three provinces. But, these increases were very gradual and displayed minimal fluctuations. Significant changes were also experienced in the mix and acreages of crops seeded. Manitoba has seen a substantial decline in summerfallow acreages. Consequently, a larger percentage of crops are now being seeded to stubble seedbed as opposed to fallow seedbed. In terms of crops sown to stubble seedbed, the major shift has been away from oats and towards wheat and rapeseed. Oats and wheat have both declined on fallow seedbed while rapeseed has seen the largest increase. Acreages of crops seeded to stubble seedbed have also increased in Saskatchewan, but this has not occurred as a

result of declining summerfallow acreages. Summerfallow acreages have remained relatively constant in Saskatchewan. Crops seeded on fallow seedbed are still predominant. As for the mix of crops on these seedbeds, the shifts experienced over the time period of analysis are similar to those in Manitoba. Changes in the mix and acreages of crops seeded in Alberta follow a pattern similar to Manitoba. The remaining component in expected cash receipts is expected prices. Since grain transportation rates have been fixed over the time period, relative changes in expected prices are the same in each province. Expected prices were fairly stable over the initial period from 1961 to 1966. Expected prices of wheat, oats and barley all rose substantially in 1967 while rapeseed and flaxseed remained the same. Expected prices for all crops, except flax, fell for the next two years. In 1970, expected prices had stablized or declined slightly for the other crops. Expected prices for grains increased in 1972 and then surged for all crops in 1973 and increased further for the next two years but, at a much smaller rate. Expected prices fell off in 1976 before increasing again in 1978. The combination of these three factors, acreages, expected yields and expected prices give the expected receipts from crops. These values, on a per farm basis, are presented in Figures 4 - 6 for each of the provinces.

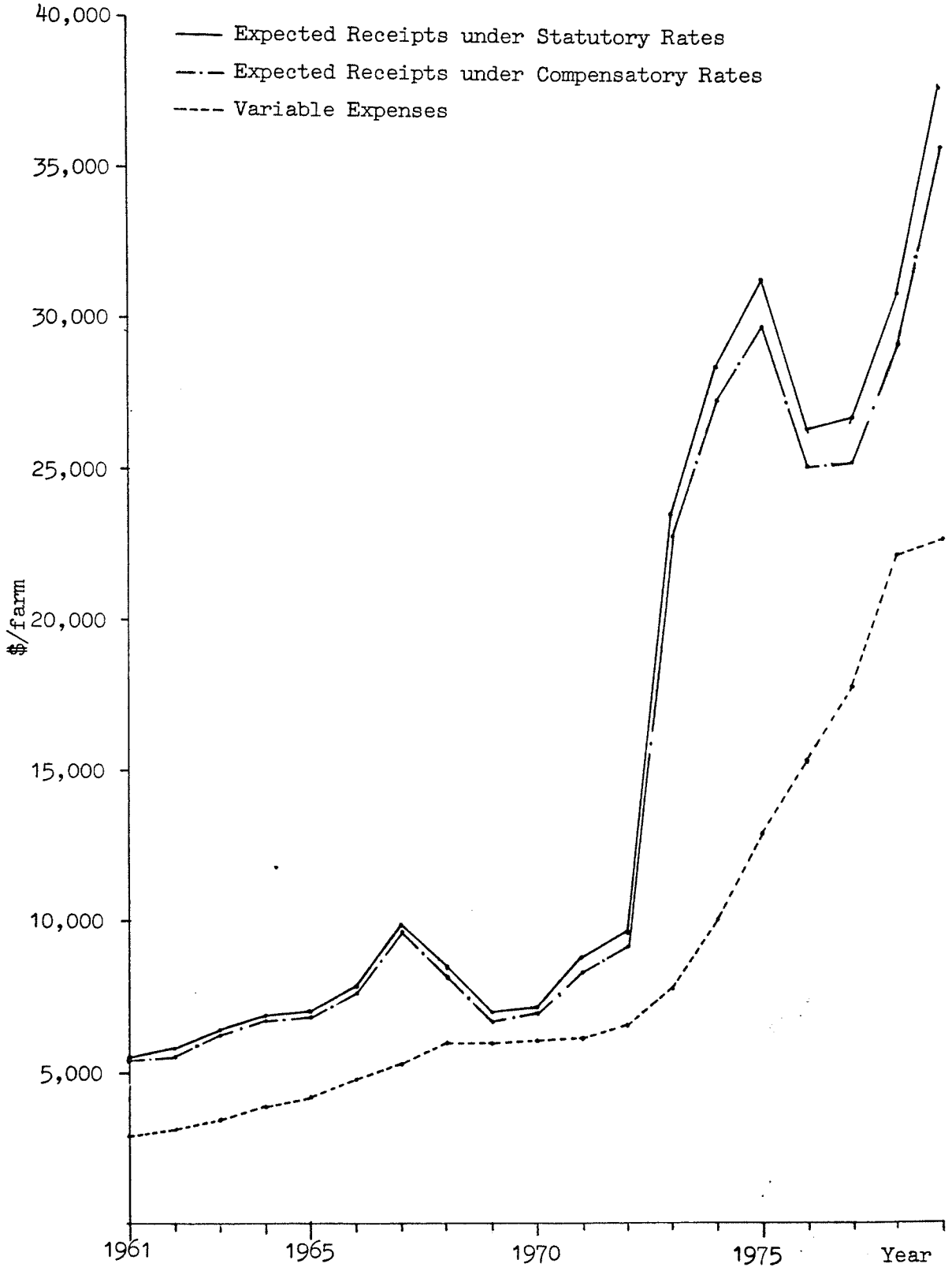


Figure 4

Expected Receipts and Expenses per Farm in Manitoba

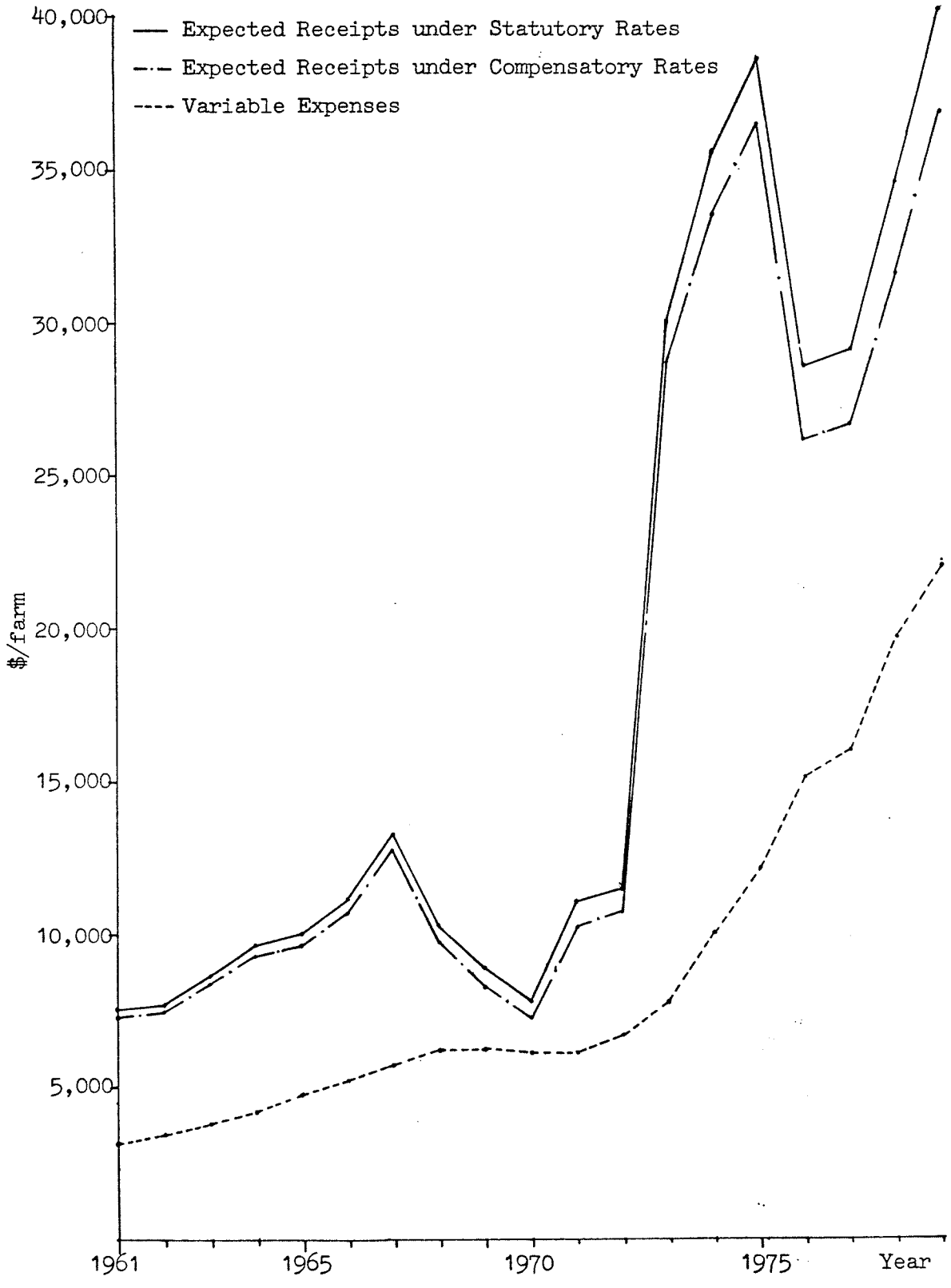


Figure 5

Expected Receipts and Expenses per Farm in Saskatchewan

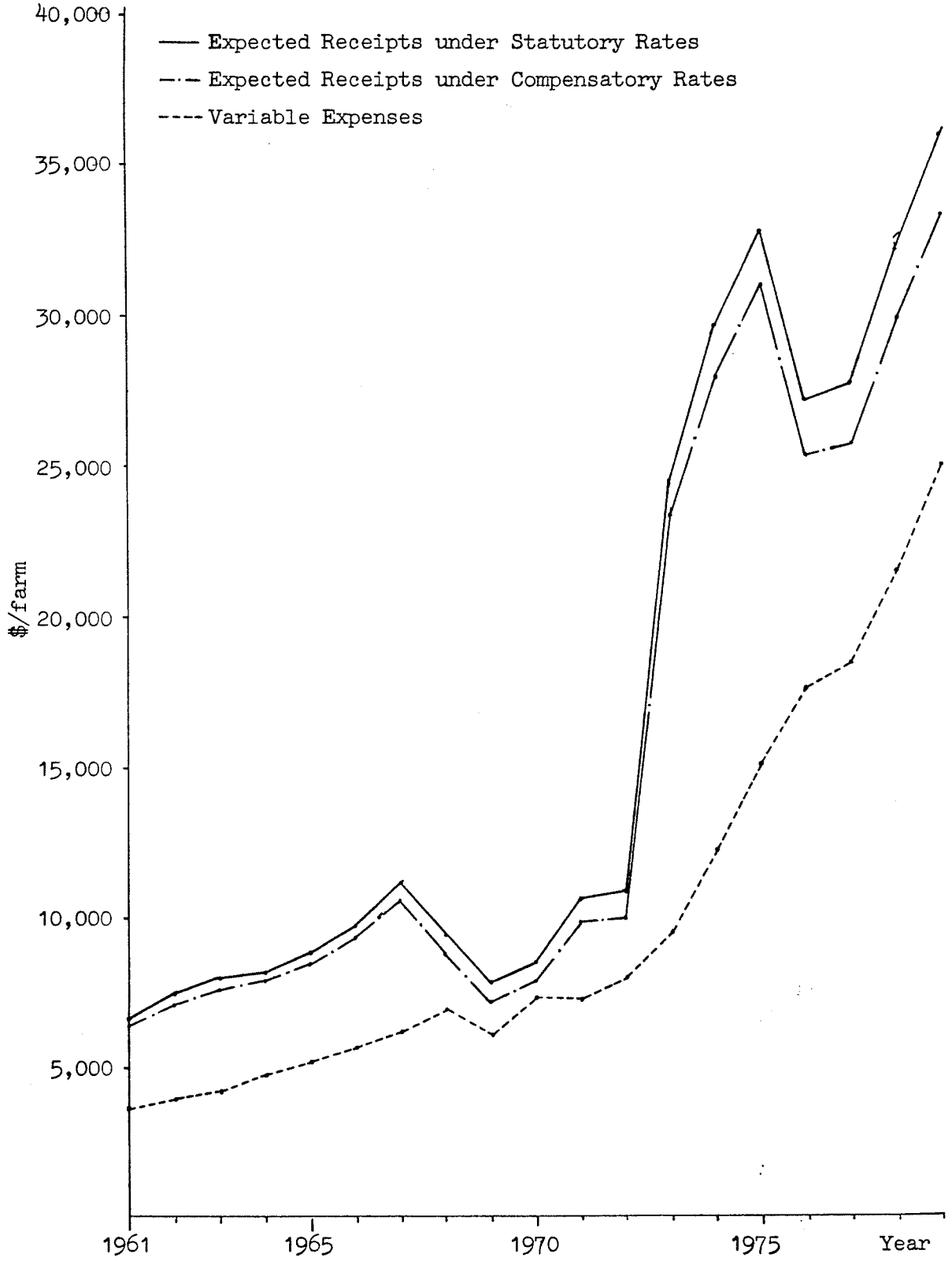


Figure 6

Expected Receipts and Expenses per Farm in Alberta

Over the initial period from 1961 to 1966, expected crop returns per farm rose gradually in all three provinces. Despite relatively stable expected prices over this period, expected crop receipts rose as expected yields and acreages rose. The surge in expected crop receipts in 1967 may be attributed largely to increased expected grain prices. In addition, there was a noticeable increase in wheat acreages largely at the expense of flaxseed. Falling expected prices for the next two years explain the drop in expected receipts. In addition, the impacts of the LIFT program were beginning to be felt. Land came out of wheat production and was summerfallowed. Manitoba experienced the largest rate of increase in summerfallow acreages over this period. Also, as a consequence of the LIFT program, expected receipts were up in 1971. Since a greater percentage of crops were seeded on fallow seedbed, as a result of the LIFT program, and summerfallow acreages were back at a normal level, expected production levels were up. Expected prices being up again in 1972 increased expected receipts. Rapidly rising prices over the next three years account for the surge in expected receipts. Expected price movements again account for fluctuating expected receipt movements in the final years. Consequently, variations in expected receipts over the entire period may be largely accounted for by movements in expected prices. Fluctuations in expected prices are generally either enhanced or stablized as gradually rising expected yields and acreages over the entire period put upward pressure on expected receipts.

The remaining component of crop cash flow is the costs. Average costs for crops per farm are also presented in Figures 4 - 6. Over the

sixties, and early seventies, average costs per farm rose very gradually with few fluctuations. Average costs per farm increased at a much more rapid rate during the latter seventies. The rising costs are a combination of increasing input levels as well as, increasing costs per unit of input. Since average costs per farm over this period display little fluctuation and are always rising, the cash flow levels in Figure 3 reflect the movements of the expected receipts. During periods when expected receipts fell, since costs were still rising, the cash flow levels show a much more pronounced down swing.

4.1.1 Crop Yield

To calculate expected cash flow levels from crops, a measurement of some anticipated permanent level of crop yields is required. The crop yield model in Chapter III is specified for this purpose. It is estimated for each crop on stubble and fallow for each province using ordinary least squares. The results of all the equations estimated in this manner are presented in Appendix B.

The intercept values indicate the expected yield levels when the influence of technological change and optimum levels of soil moisture are held constant. Because the model specification involves a multiplicative format, the equation is linearized by taking the logarithm of the function for estimation purposes. Only the intercept value is affected when the results of this estimation are transformed back to the original specification. In presenting the results, both intercept values are recorded. The additive intercept refers to the value in the logarithmic function whereas, the multiplicative intercept refers to the value in

the original specification. For Manitoba, the intercept value is determined as the product of b0 and CD^{b5}. The value of b0 represents the expected yield level for crop district 14. The impacts of the remaining crop districts on the expected yield level for the province are incorporated through the use of a series of dummy variables. The value of CD^{b5} is determined by weighting the associated coefficients on the dummy variable for each crop district by the 1976 seeded acreage level. For each crop, the intercept value for the fallow equation is always higher than on the stubble equation. This can be attributed to higher nutrient levels, higher conserved moisture levels, and reduced weed problems on fallow land.

All the parameters on the weather variables included in the specification indicate an excess or shortage of moisture suppressed yields. Consequently, the value of the intercept is reduced to reflect average weather conditions where moisture problems reduced yield. This adjusted intercept value is recorded in the results. The adjusted intercept is interpreted as the expected yield level without any influence of varietal development and fertilizer use.

Technological change is incorporated into the model through the variables for the genetic improvement index and the fertilizer use levels. Multiplying the varieties grown and fertilizer rates as they were adopted by farmers by their associated equation parameters forecasts a series of expected yield levels under normal weather conditions.

No significant statistical relationship could be estimated for rapeseed on fallow in Manitoba or rapeseed on stubble or fallow in Saskat-

chewan. In these cases, expected yields are taken as the average yield over the period of observations.

For discussion purposes, one equation, wheat grown on stubble seedbed in Manitoba, is examined in detail. This estimated equation is given in Equation 22.

$$Y = 13.09 * V * F^{0.22} * DM1^{-0.16} * DM2^{-0.03} * e^{-0.16EM1} * e^{-0.03EM2} \quad (22)$$

where: 13.09 = antiln(b0 + CD)

b0 = 2.37

CD = 0.20

This equation was estimated using 208 observations on a crop district basis. The variables incorporated accounted for 56 percent of the variation in wheat yields. If the influence of technological change was removed and soil moisture did not limit yields, the equation indicates average stubble wheat yields in the province would be 13 bushels per acre. This consists of the base crop district number 14 yield of 10.7 bushels per acre (antiln 2.37) which was increased 1.22 fold (antiln 0.20) when the remaining crop districts were included.

Technology related variables included were the genetic improvement index (V) and fertilizer use levels (F). The parameter estimated on the fertilizer variable indicates the elasiticity of wheat yield with respect to fertilizer application is 0.22. That is, a one percent increase in fertilizer application rates (lbs./acre) may be anticipated to

increase yield (bu./acre) levels by 0.22 percent. With such a yield response to fertilizer, application rates will increase provided the resulting impact on yield, and therefore receipts, is sufficient to cover the additional costs of fertilizer applications.

Weather variables included in the specification are soil moisture deficits (DM1 and DM2) and excess precipitation (EM1 and EM2). Soil moisture deficits during the first 60 days of growth (DM1) ranged from 1 to 75 mm with an average of 5.6 mm. A one percent increase in soil moisture deficits during this time period depress wheat yields by 16 percent. On average, soil moisture levels during the first 60 days of growth depressed yields 12 percent. Soil moisture deficits during the last 30 days of growth (DM2) ranged from 1 to 35 mm with an average of 9 mm. A one percent increase in soil moisture deficits during this time period depresses wheat yields by 3 percent. On average, soil moisture levels during the last 30 days of growth depressed yields 6 percent. Average excess moisture levels of 0.2 and 0.09 were experienced during the first 30 days of growth and the second 30 days of growth, respectively. Therefore, on average, excess moisture reduced provincial wheat yields by 3 percent.

The intercept value indicates average wheat yields on stubble seedbed in Manitoba is 13 bushels per acre when the influence of technological change and optimum levels of soil moisture are held constant. In formulating some anticipated level of yields, average weather conditions are considered. Consequently, the intercept is adjusted downward 20 percent (10 bu./acre) when average moisture levels are incorporated. Thus, the

expected yield level for wheat on stubble seedbed in Manitoba is taken to be 10 bushels per acre multiplied by some factor to account for the level of technological change being considered.

4.1.2 Technological Change

Technological change is incorporated into the expected crop cash flow model in two ways. Biological advances are included in the expected crop yield model through the variables accounting for varietal developments and the fertilizer application rates. Mechanical advances are included by examining expected crop cash flow levels on a per farm basis since the adoption of mechanical technology has resulted in increased farm sizes. Tables 3 - 5 show the impacts the adoption of higher fertilizer application rates and mechanical advances have had on expected crop cash flow levels by restraining technology at the level experienced in 1961.

Expected crop cash flow levels have been augmented through varietal improvement and increased fertilizer and pesticide use. Increased fertilizer application rates alone account for a substantial portion of the increased crop cash flow levels. The extent of this impact may be measured by calculating expected crop cash flow levels when fertilizer application rates are held at the 1961 level. Fertilizer expenditures are also held at the 1961 level and are adjusted upwards by the farm input price index of fertilizer. The impact of the adoption of higher fertilizer application rates on expected crop cash flow levels appears to be more pronounced than from the adoption of mechanical advances. The results show by 1979, holding all other factors constant, increased

TABLE 3

Expected Crop Cash Flow per Farm under Various Levels of Technology and Grain Freight Rates in Manitoba

Year	Estimation of Actual Levels ($/farm)	Fertilizer Application Rates fixed at 1961 Level ($/farm)	Mechanical Innovations fixed at 1961 Level ($/farm)	Compensatory Grain Freight Rates ($/farm)
1961	2547	2547	2547	2438
1962	2373	2302	2293	2250
1963	2928	2684	2772	2790
1964	3000	2663	2799	2842
1965	2834	2306	2626	2656
1966	3031	2100	2775	2796
1967	4574	3286	4084	4303
1968	2496	1412	2305	2185
1969	1016	363	1050	712
1970	1183	440	1136	867
1971	2719	1741	2246	2264
1972	3051	1773	2464	2550
1973	15772	10494	11963	15023
1974	18104	11637	13703	17051
1975	18396	12226	14070	17285
1976	10964	5948	9008	9621
1977	8858	4544	7485	7443
1978	8744	3994	7433	7053
1979	11967	5301	9565	9989

TABLE 4

Expected Crop Cash Flow per Farm under Various Levels of Technology and Grain Freight Rates in Saskatchewan

Year	Estimation of Actual Levels ($/farm)	Fertilizer Application Rates fixed at 1961 Level ($/farm)	Mechanical Innovations fixed at 1961 Level ($/farm)	Compensatory Grain Freight Rates ($/farm)
1961	4270	4270	4270	4040
1962	4228	4053	4110	3961
1963	4878	4283	4667	4564
1964	5397	4265	5108	5036
1965	5243	3904	4947	4819
1966	5912	4067	5539	5387
1967	7618	5141	6989	7044
1968	4045	2133	3808	3419
1969	2509	1473	2417	1843
1970	1739	1231	1675	1193
1971	4969	4133	4183	4126
1972	4818	3412	4017	3928
1973	22239	16334	17687	20876
1974	25518	16930	20217	23469
1975	26434	17593	21076	24254
1976	13421	7435	11647	11031
1977	13046	7277	11028	10502
1978	14971	7861	13047	11815
1979	18287	10033	15782	14851

TABLE 5

Expected Crop Cash Flow per Farm under Various Levels of Technology and Grain Freight Rates in Alberta

Year	Estimation of Actual Levels ($/farm)	Fertilizer Application Rates fixed at 1961 Level ($/farm)	Mechanical Innovations fixed at 1961 Level ($/farm)	Compensatory Grain Freight Rates ($/farm)
1961	2884	2884	2884	2686
1962	3440	3295	3375	3218
1963	3668	3319	3550	3402
1964	3545	3030	3412	3254
1965	3744	3120	3602	3416
1966	4150	3386	3981	3757
1967	4880	3821	4605	4439
1968	2476	1745	2468	1982
1969	1724	1343	1772	1211
1970	1127	740	1238	612
1971	3302	2859	2936	2628
1972	2926	2130	2636	2172
1973	15049	11052	12470	13971
1974	17344	12275	14548	15779
1975	17743	13097	15294	16059
1976	9736	6367	9433	7869
1977	9296	6314	9333	7396
1978	10689	7635	10677	8504
1979	11075	7521	11235	8607

fertilizer application rates can account for 56, 45 and 32 percent of expected crop cash flow levels per farm in Manitoba, Saskatchewan and Alberta, respectively.

The adoption of mechanical advances has resulted in average farm sizes increasing from 420, 686 and 645 acres in 1961 to 650, 941 and 832 acres in 1979 in Manitoba, Saskatchewan and Alberta, respectively. The impact of the increasing average farm sizes on expected crop cash flow levels per farm are shown in Tables 3 - 5 where crop cash flow levels are calculated assuming 1961 farm sizes are maintained over the period of analysis. Capital expenditures are also maintained at the 1961 level and are adjusted upwards in each year by the farm input price index for machinery replacement. The results of the expected crop cash flow levels are interesting when compared to the original series, especially over the last few years. The results show by 1979, holding all other factors constant, the increased farm sizes can account for 20 and 14 percent of expected crop cash flow levels per farm in Manitoba and Saskatchewan, respectively. In Alberta, it appears the rise in capital expenditures, especially in the final few years, has increased at a faster rate than average farm size. Consequently, a problem of over capitalization appears to have developed. In all provinces, the results indicate the increases in expected crop cash flow levels derived from mechanical innovations have been stabilizing.

4.1.3 Grain Freight Rates

Central to the analysis is the impact compensatory grain freight rates would have had on the expected crop cash flow levels. The results of the price indexing procedure adopted to estimate compensatory rates is given in Appendix B. The results show the grain freight rates would have to increase by 1.4 fold in 1961 and by 3.7 fold in 1979. The impact of such increases on expected crop cash flow levels are presented in Tables 3 - 5.

Since these adjusted rates are assumed to only affect expected prices of statutory grains, the impact on expected crop cash flow levels is realized through alterations to expected crop receipts. The expected crop receipts are graphically depicted in Figures 4 - 6 where they are directly comparable to expected crop receipts under the statutory rate structure. Since statutory freight rates have been fixed over time while compensatory rates have increased, the dampening effect on expected crop receipts increases over time.

Provincial differences in the percentage drop in expected crop receipts between statutory and compensatory grain freight rates reflect differences in the proportion of grains to oilseeds produced. Since oilseeds are transported at a higher rate than grains, and all rates are adjusted by the same index to derive compensatory rates, the higher the proportion of oilseeds produced, the larger the reduction in expected crop receipts. Provincial differences in the percentage drop in expected crop cash flow per farm not only reflect the drop in crop receipts but also the associated costs. Since crop costs per farm rela-

tive to expected crop receipts per farm is the largest for Alberta, the percentage drop in expected crop cash flow per farm is greater in Alberta than the other provinces.

In 1979, the results show compensatory rates would have decreased expected crop cash flow levels by 17, 19 and 22 percent in Manitoba, Saskatchewan and Alberta, respectively. Since land prices are expected to accelerate at the same rate as cash flow in the long run, a similar level of impact is anticipated to occur in land prices.

As the divergence between statutory and compensatory rates become more pronounced, there is a widening gap between the two expected crop cash flow series. In order to maintain cash flow levels in face of rising costs, increased production levels per farm will be required. From the results in Tables 3 - 5, it would appear such increases will be dependent upon future biological innovations since the benefits from mechanical innovations appear to have stabilized.

4.2 LAND PRICE MODEL

An annual measurement of expected crop cash flow levels is estimated for each province in the manner described in Equation 8. Using these values, the land price model specified in Chapter III is estimated for each province using ordinary least squares. The Cochrane-Orcutt iterative technique is incorporated in each estimation to correct for autocorrelation. The results are presented in Table 6. A comparison of the actual land prices in each province to those predicted from the regress-

TABLE 6

Land Price Model Results

	MANITOBA	SASKATCHEWAN	ALBERTA
Intercept			
Additive	-0.36 (0.13)[b]	-0.48 (0.19)[b]	-0.73 (0.73)[b]
Mult (a0)	0.70	0.62	0.48
Expected Crop Cash Flow per Farm (a1)	0.09 (0.01)[a]	0.09 (0.02)[a]	0.09 (0.03)[a]
Lagged Land Price (a2)	0.93 (0.03)[a]	0.95 (0.04)[a]	1.00 (0.06)[a]
Adjusted R^2	0.98	0.97	0.95
L.H.S. Mean	4.58	4.44	4.66
S.E.	0.04	0.06	0.08
Durbin-H	-0.26	-0.08	0.08

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level.

ion equations are presented in Figures 7 - 9. Values of the predicted land prices are given in Appendix B.

In order to linearize the model specification, a logarithmic format is estimated. The only coefficient altered in transforming this specification back to the original one is the intercept. For this reason, both intercepts are recorded. The additive one refers to the logarithmic specification whereas, the multiplicative one refers to the original model specification.

In all three provinces, lagged land price and expected crop cash flow levels explain over 95 percent of the variations in land prices. The regression coefficients are of the magnitude expected and very similar between provinces. This result is not surprising considering the similarity of the grain industry in all three provinces. The provinces are each influenced by the Canadian Wheat Board, and thus receive comparable prices. They are each subject to the same transportation environment and must pay similar prices for all variable inputs. Consequently, if variations in land prices are influenced by cash flow levels related to the grain industry, one would expect similar farm land market characteristics across the Prairies. Both variables in all provinces have a significant impact on land prices at the 1 percent level.

In the previous discussion on the model specification, it was argued long-run equilibrium land prices should appreciate at the same rate as cash flow per farm. This implies the regression coefficients a1 and a2

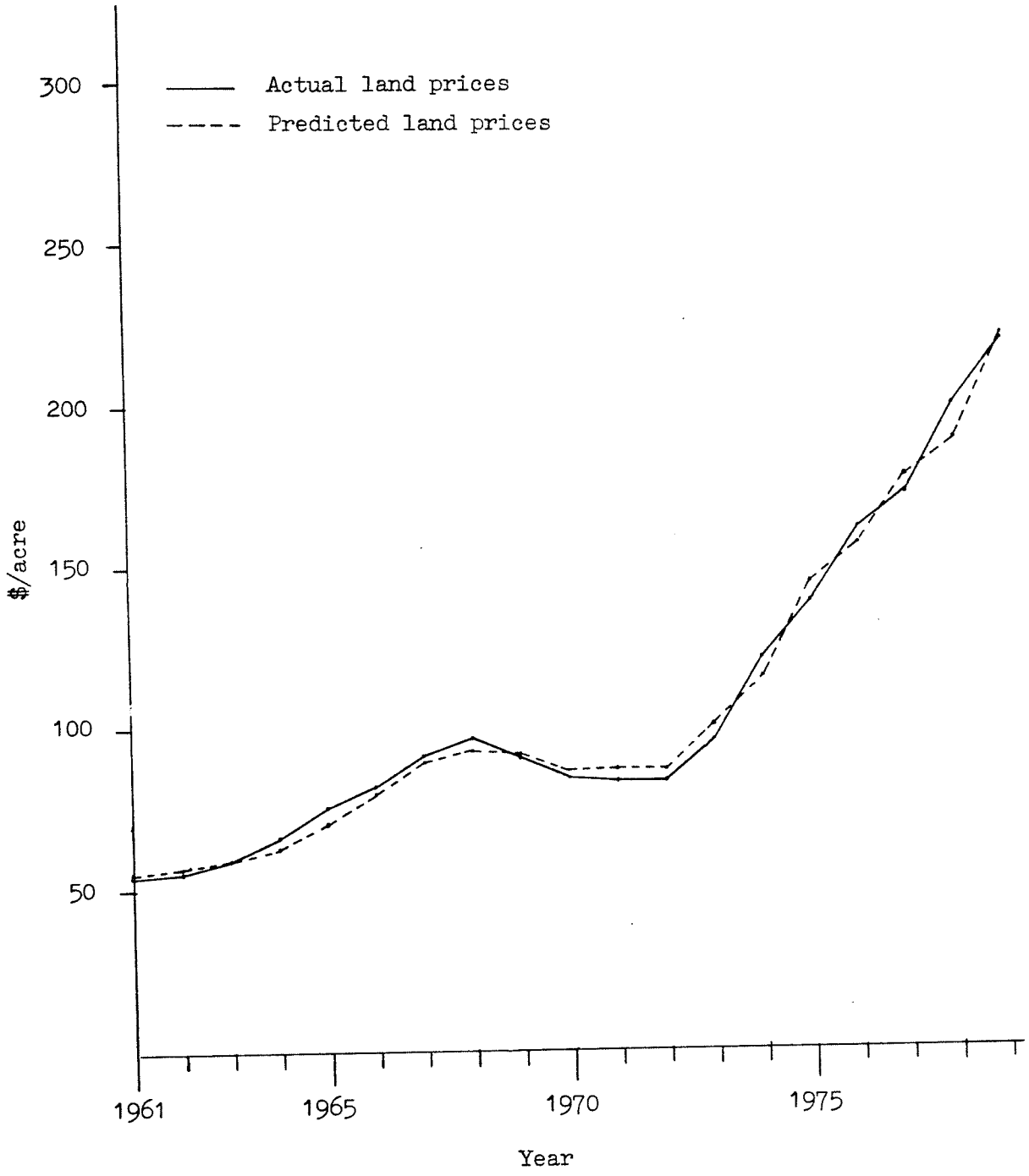


Figure 7

Actual and Predicted Land Prices in Manitoba from 1961 to 1979

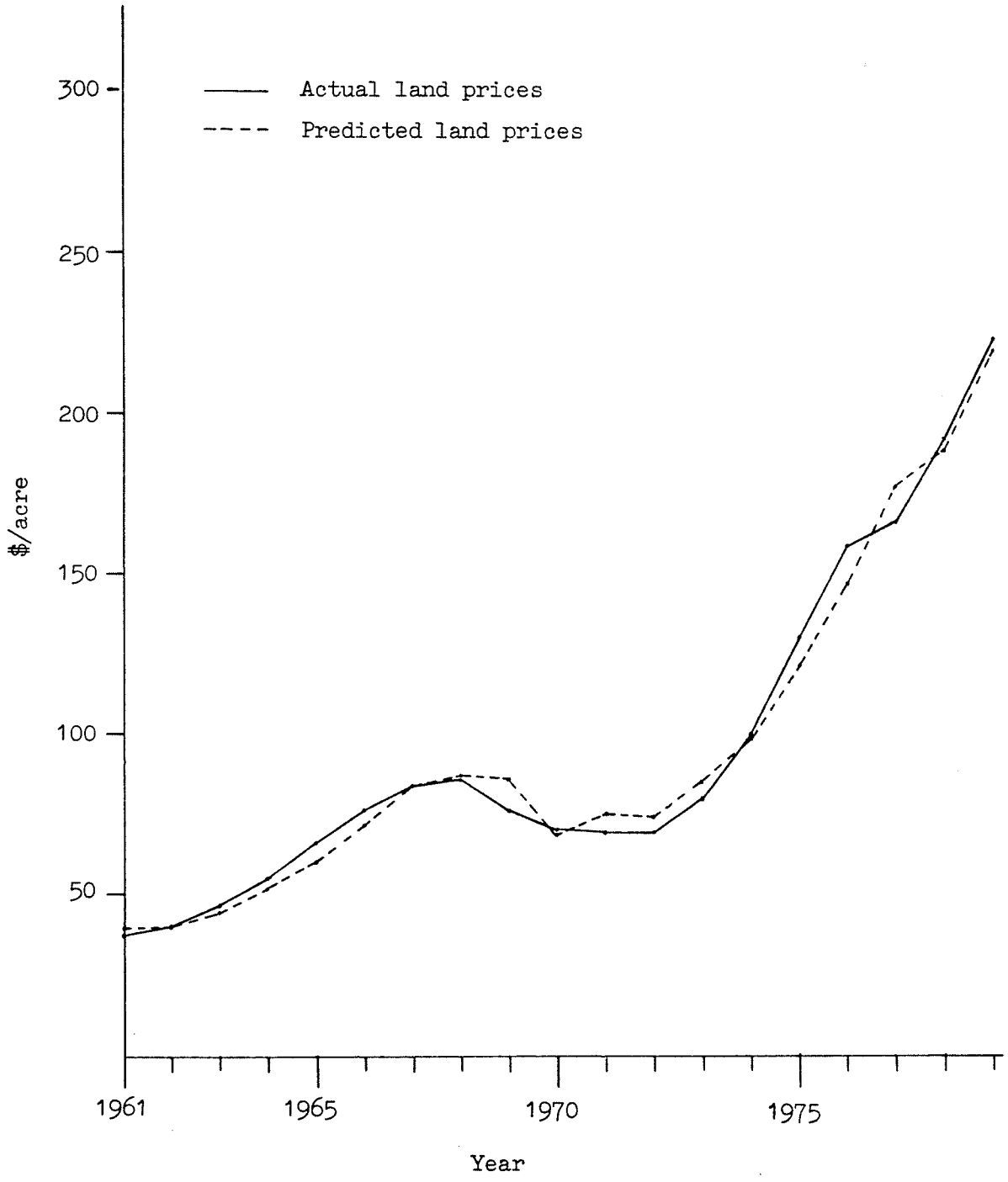


Figure 8

Actual and Predicted Land Prices in Saskatchewan from 1961 to 1979

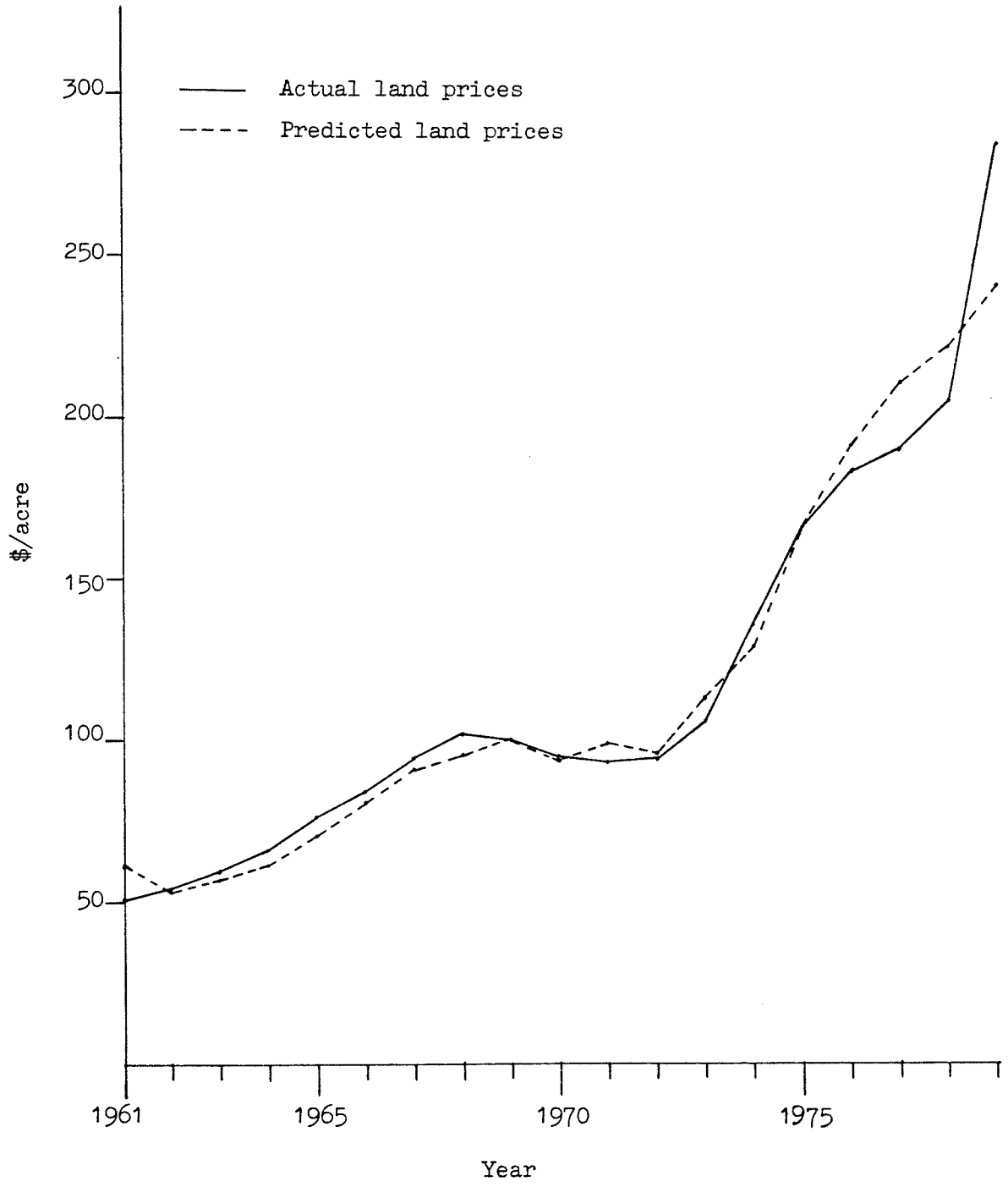


Figure 9

Actual and Predicted Land Prices in Alberta from 1961 to 1979

should sum to one. From Table 6, the sum of these coefficients is greater than one in each province. At the same time though, it would appear their sum may not be statistically significantly different from one.

Given the model specification as in Equation 8, the following null hypothesis may be tested:[32]

$$H_0: a1 + a2 = 1.$$

Let $C = [0\ 1\ 1\ 0]$

and

$$A = \begin{bmatrix} a0 \\ a1 \\ a2 \\ rho \end{bmatrix}$$

then, $H_0: C'A = 1$

may be tested using the following t-distribution with (n-k) degrees of freedom

$$t = \frac{C'\hat{A} - C'A}{s\sqrt{C'(X'X)^{-1}C}}$$

where:

$$s = \sqrt{\sum_{i=1}^{n} e_i^2 /(n-k)} \quad .$$

[32] J.Johnston, Econometric Methods, second edition, McGraw-Hill Book Company, New York, 1972, p.155.

The calculated t-values from the regression results are as follows:

Manitoba	0.16
Saskatchewan	0.21
Alberta	0.40 .

With 15 degrees of freedom and a 5 percent significance level, the null hypothesis cannot be rejected. That is, the sum of the regression coefficients a1 and a2 is not statistically different from one. Therefore, a 1 percent increase in permanent crop cash flow has resulted in a 1 percent increase in farm land prices for each province.

The land price equations for the three provinces are re-estimated as in the original model specification but also incorporating the following linear restriction:

$$a1 + a2 = 1.$$

The results of this linear restriction on the estimation of the parameters of the land price model are given in Table 7. A comparison of these results to those in Table 6 shows the effects of incorporating the linear restriction. The lagged land price and expected crop cash flow levels are still capable of explaining a similar percentage of the variations in land prices. The coefficient on expected crop cash flow only changes marginally in Saskatchewan and maintained the same level in the other two provinces. The coefficient on lagged land price declined in all three provinces in order to comply with the linear restriction imposed. The parameters on both variables in all three provinces maintained their significance at the 1 percent level. At the same time, the

TABLE 7

Land Price Model Results under Linear Restriction

	MANITOBA	SASKATCHEWAN	ALBERTA
Intercept			
Additive	-0.27 (0.13)[b]	-0.28 (0.21)[c]	-0.29 (0.29)[ns]
Mult (a0)	0.76	0.75	0.75
Expected Crop Cash Flow per Farm (a1)	0.09 (0.01)[a]	0.08 (0.02)[a]	0.09 (0.03)[a]
Lagged Land Price (a2)	0.91 (0.03)[a]	0.92 (0.04)[a]	0.91 (0.07)[a]
Adjusted R^2	0.98	0.96	0.94
L.H.S. Mean	4.58	4.44	4.66
S.E.	0.04	0.06	0.08
Durbin-H	-0.26	-0.04	0.07

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level.

intercept (a0) increased in all equations to compensate for the effects of the linear restriction. Again, the estimated equations for the provinces are virtually identical.

In formulating the crop cash flow model, the assumption that expected crop prices are linked to the export market was examined. If when grain stocks increased on farms, the Prairie feed grain buyers did not have to compete with the export buyers, then the export prices used in the model may not represent expected prices in these circumstances. In order to account for the Prairie feed grain market, a grain inventory variable was included in the land price model. It was hypothesized if during periods when grain stocks accumulated on farms resulted in relatively lower Prairie feed grain prices, an inventory variable should display some significance. But, no statistical significance could be shown. Therefore, it was concluded expected grain prices do not reveal any significant difference from export prices when estimating their influence on the farm land market.

4.3 HISTORICAL SIMULATIONS

Two sets of simulations are generated over the period of observations from 1961 to 1979. This involves the use of two series of expected crop cash flow levels. One series represents actual levels while the other represents expected cash flow levels when compensatory freight rates are in effect. Both series are derived using the estimated relationships from the crop yield model, expected crop prices and actual acreages and costs. The only difference between the two series involves expected crop prices to the extent they are affected by grain freight rates.

Thus, the historical simulation under compensatory rates assumes the cropping pattern would not change because of the higher grain freight rates.

Given the estimated expected crop cash flow levels under the two sets of grain freight rates and the relationships established in the land price model, land prices are simulated under the two transportation rate scenarios. Beginning with the 1960 actual land price and the 1961 expected crop cash flow level, the 1961 land price is simulated using the equations in Table 6. This recursive procedure utilizing the estimated land price from the previous year and the expected crop cash flow allows for a simulation of land prices to 1979.

These simulated land prices, along with the actual land prices, are presented for each province in Figures 10 - 12. Values for these simulated prices are given in Appendix B. The simulated land prices under statutory freight rates provide a benchmark simulation. In order for the simulation procedure to be useful, this benchmark simulation should closely track actual land prices.

In all three provinces, land prices rose steadily from 1961 to 1968, dropped in 1969 and 1970 and stabilized in 1971 and 1972 and then, began accelerating rapidly. The simulation of those actual land prices manages to account for the major turning points and come very close to actual land prices in 1979. The magnitude of the surge and fall of land

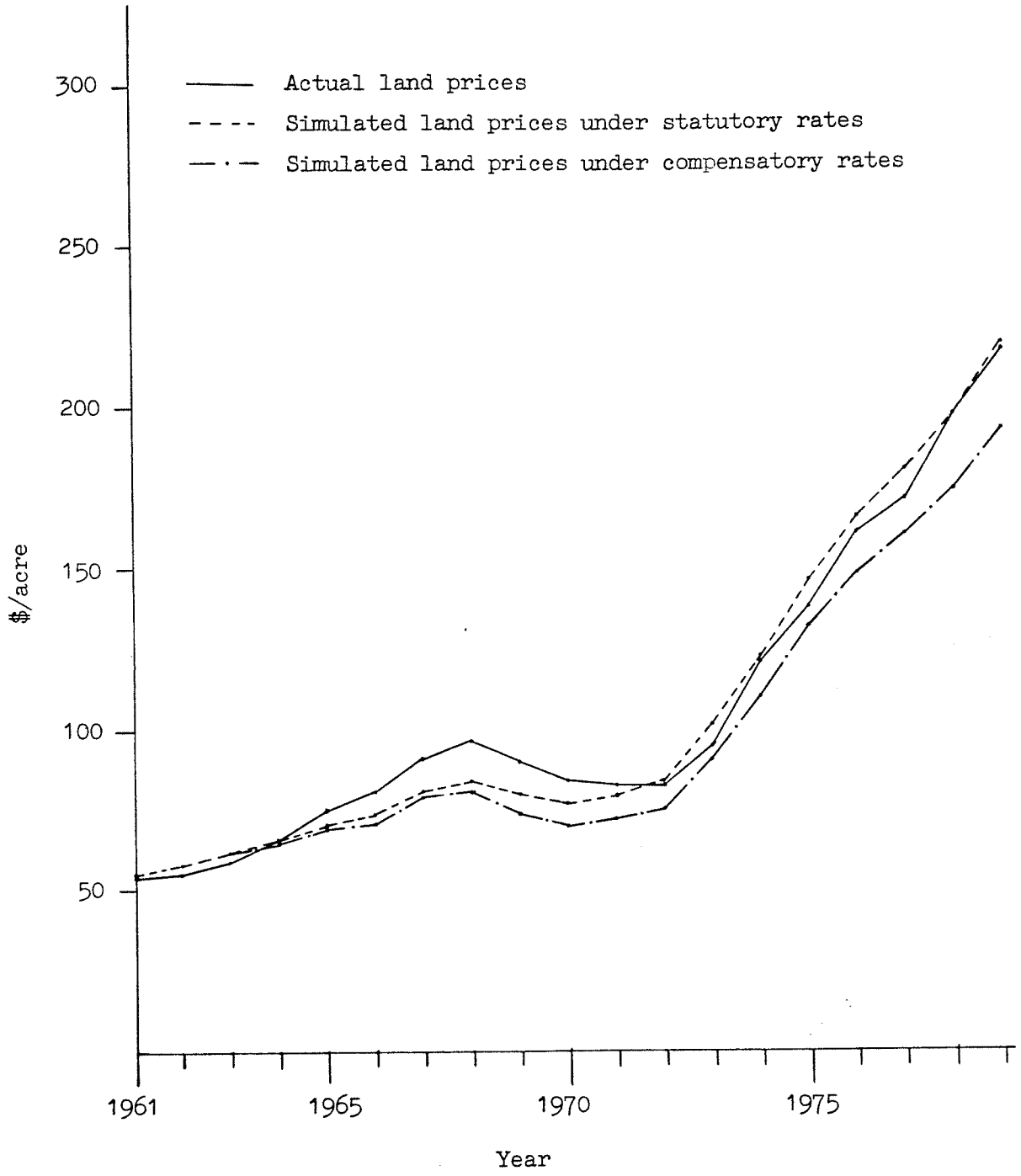


Figure 10

Actual and Simulated Land Prices in Manitoba from 1961 to 1979

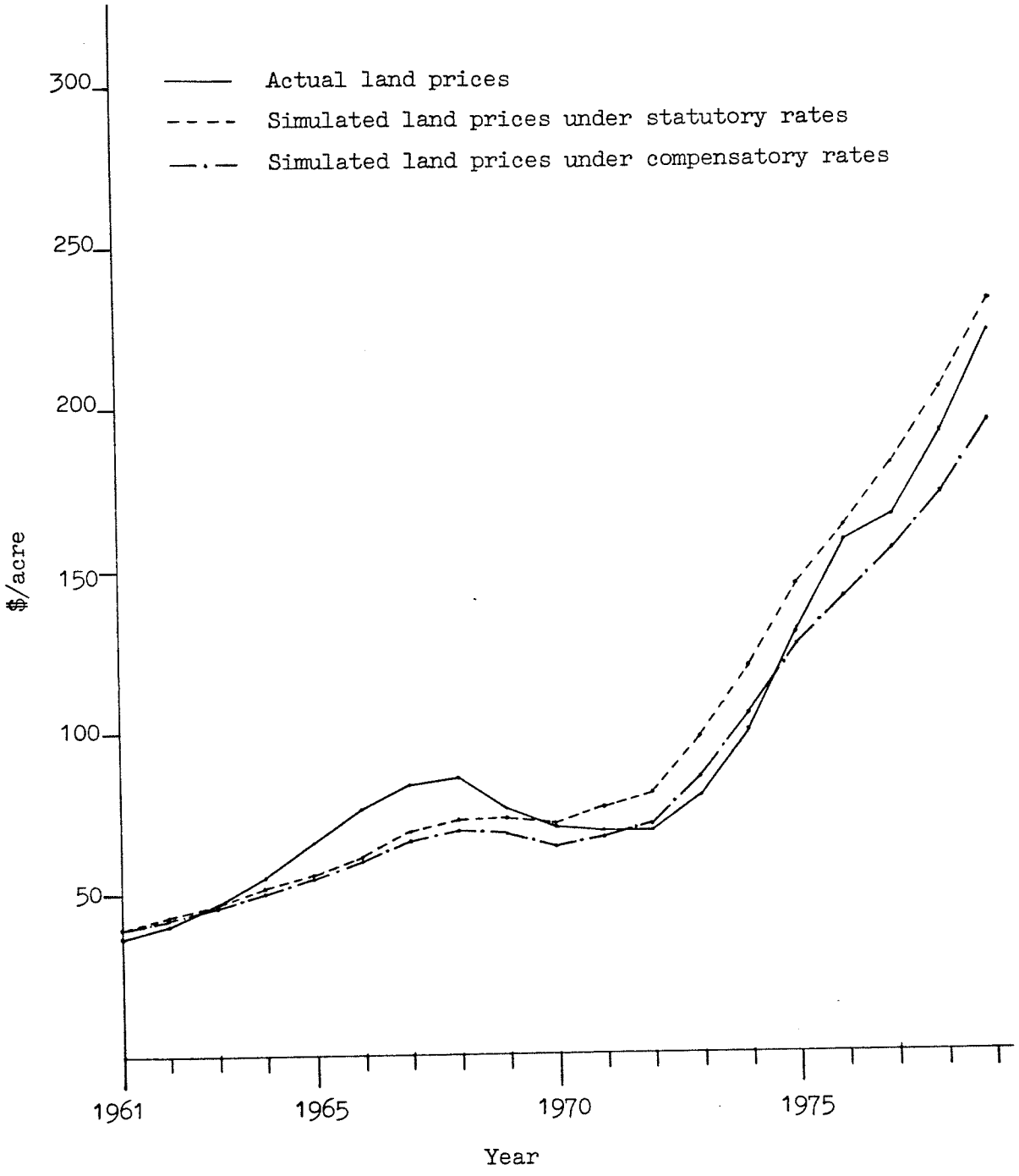


Figure 11

Actual and Simulated Land Prices in Saskatchewan from 1961 to 1979

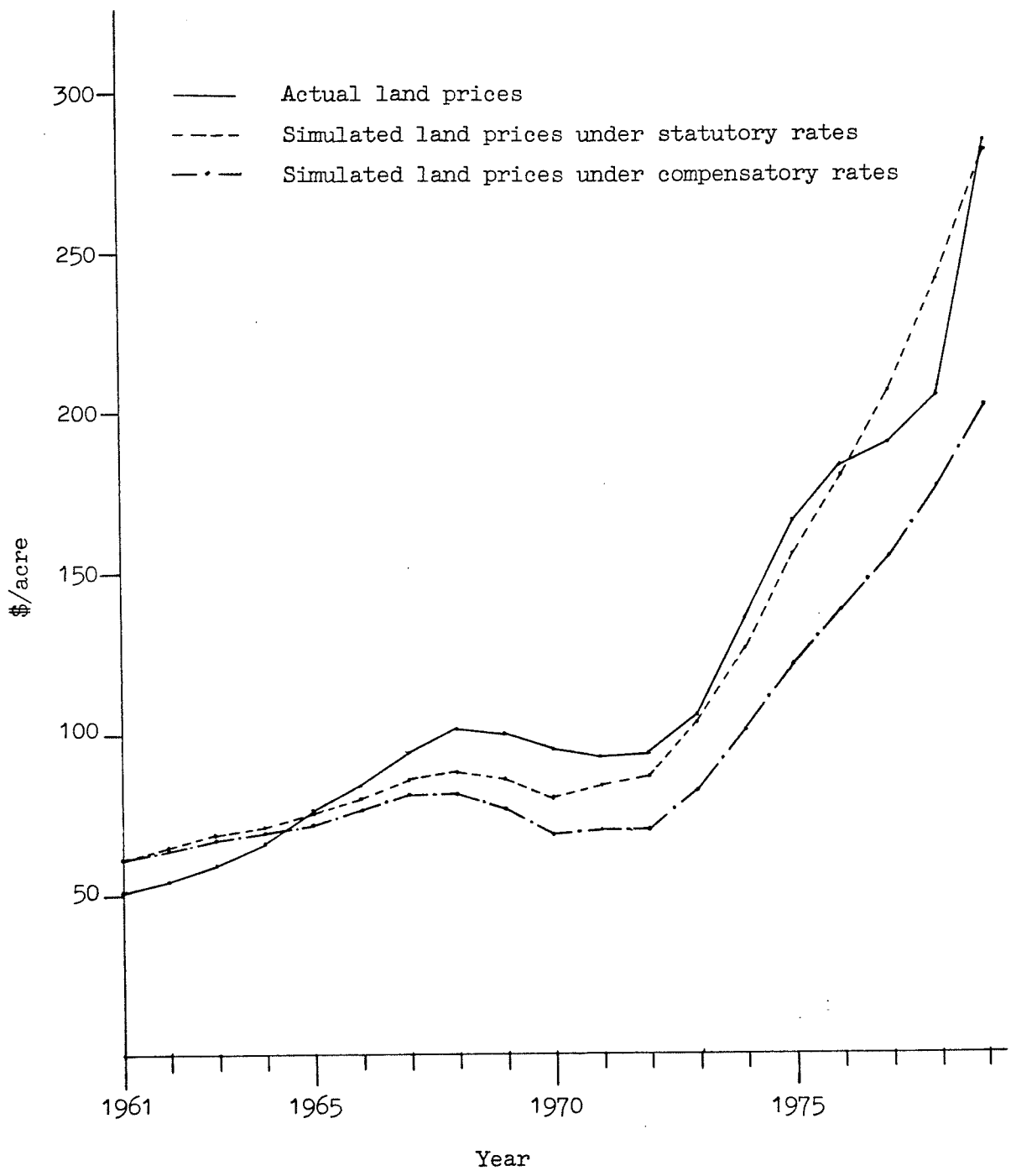


Figure 12

Actual and Simulated Land Prices in Alberta from 1961 to 1979

prices in the earlier years is neutralized by the simulation.[33]

The second simulation of land prices incorporates the effects of reduced expected crop cash flow levels on land prices when compensatory grain freight rates are paid by producers. Higher transportation rates affect land prices in the current and future years. Because statutory freight rates have been fixed over time while compensatory rates have increased, the dampening effect on cash flow levels increases over time. In addition, because of the recursive nature of the model, decreased land prices in the current year have a dampening effect on land prices in the following year. These effects account for the widening gap between the two simulations. This gap measures the degree to which the statutory rates have been capitalized into land prices.

Using the difference between the two land price simulations in 1979, Table 8 presents a measure of the capitalized value of the statutory freight rates into farm land prices over the period from 1961 to 1979. Given the difference between the statutory and compensatory rates in 1961 is negligible relative to more recent years, the calculated capitalized values may be considered to closely approximate the total capitalized value since the two rates began to diverge. From Table 8 the results reveal 13, 17 and 28 percent of the 1979 farm land value in Manitoba, Saskatchewan and Alberta, respectively, may be attributed to the statutory rates. Differences in expected crop cash flow levels per farm

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[33] In the case of Alberta, the sudden change in the rate of increase in land prices recorded by Statistics Canada in the last three years is in suspect. This may be concluded since land price movements in the three provinces are very similar except for Alberta in this period. If this is so, it could account for the inability of the benchmark simulation to track well over the last few years.

TABLE 8

Capitalized Values of the Statutory Rates into Farm Land Prices on the Prairies from 1961 to 1979

	Farm Land Acreage ('000 acres)	Land Price Attributable to the Statutory Rates ($/acre)	(% of 1979 price)	Capitalized Value ($ million)
Manitoba	19036.7	27.6	12.7	525.4
Saskatchewan	65784.1	38.0	17.0	2499.8
Alberta	50182.3	80.0	28.0	4014.6
Prairies				7039.8

due to compensatory rates are calculated to be 17, 19 and 22 percent for Manitoba, Saskatchewan and Alberta, respectively. Land prices are expected to change by a similar magnitude in the long run. Therefore, the capitalized value in 1979 of statutory freight rates into farm land prices would be anticipated to be somewhat less than these values. Such is the case for Manitoba and Saskatchewan. Since the sum of the coefficients on lagged land price and expected crop cash flow are greater than one, the impact in Alberta is greater than anticipated. Based on farm land acreages in these provinces, the total value of farm real estate in the Prairie provinces has been increased by $7 billion, or 21 percent, as a result of the maintenance of statutory freight rates over compensatory rates.

4.4 IMPACTS OF INCREASED FARM LAND PRICES

The analysis suggests the maintenance of the statutory freight rates has inflated farm land prices in the Prairie provinces. At the same time, rising farm land prices influence wealth distribution by increasing the wealth of current owners. Consequently, the maintenance of the unremunerative grain freight rates have definite implications with regards to wealth distribution.

To determine how the benefits of the statutory rates have been distributed among farm land owners, the concentration of land ownership over time in the Prairie provinces is examined. Using census data available for the years 1961, 1966, 1971 and 1976, for various groups of farm sizes, the percentage of farms in each group owning land may be compared to the percentage of land controlled by each group. If the

cumulative percentages of these two categories are plotted against one another, a Lorenz curve is derived. Such a curve is compared to the diagonal as a 45° line represents equality in the number of farms to farm land ownership.

A Lorenz curve for Manitoba in 1976 is presented in Figure 13. This curve is also representative of the relationships in the other two Prairie provinces. The curve gives an indication of how the benefits of the statutory rates have been distributed among farm land owners. Twenty-five percent of the farms control only 7 percent of the land, consequently 7 percent of the benefits of the statutory rates are distributed among 25 percent of the farmers. Similarily, 25 percent of the benefits are distributed among half the farms and half the benefits are distributed over 75 percent of the farms. The remaining half of the benefits are distributed over only 25 percent of the farms. A comparison of Lorenz curves in each year determines if this pattern of land ownership has changed.

For ease in comparison of Lorenz curves, the Gini Index of Concentration or the Gini Ratio[34] is derived. The Gini Ratio measures the proportion of the total area under the diagonal that is between the Lorenz curve and the diagonal. The Gini Ratio provides for ease in comparison of Lorenz curves as it consists of one statistic.[35] These ratios

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[34] A discussion of the Gini Ratio and its computation is presented in: "The Use of the Gini Ratio in Measuring Distributional Impacts", paper prepared by Charles H. Riemenschneider, Department of Agricultural Economics, Michigan State University.

[35] This is true so long as the Lorenz curves do not cross. The Lorenz curves do not cross for the years examined therefore, the Gini Ratio may be compared across years.

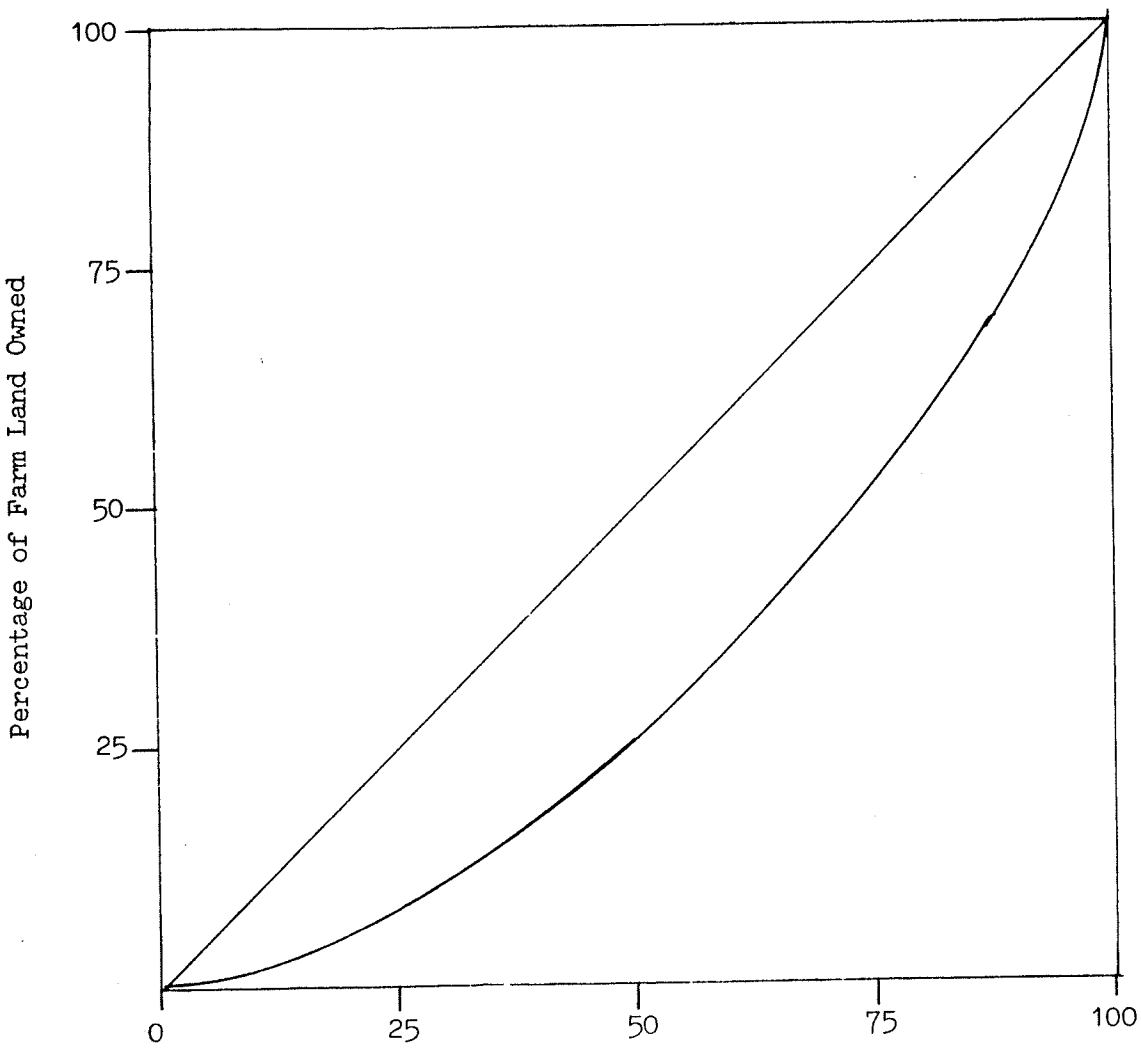


Figure 13

Lorenz Curve for Manitoba in 1976

calculated to compare farm land sizes to their ownership are given for the census years in the Prairie provinces in Table 9. Values of Gini Ratios will lie between zero and one. A value of zero indicates perfect equality and occurs when the Lorenz curve coincides with the diagonal line. At the other extreme, a value of one indicates perfect inequality in the distribution of land ownership. It appears this ratio has not changed substantially. Therefore, there has not been an increasing concentration of the benefits of the statutory freight rates in terms of increased land values. That is, over time, the distribution of the benefits of the statutory rates among farms has not changed to any significant degree.

Landowners who sold land since the statutory rates became unremunerative already have realized the increase in their wealth. This has occurred because such land sales took place at inflated prices resulting from the statutory rates. The level of increase in the landowner's wealth related to the statutory rates depends upon the time periods in which the purchase and sale of land are made. The historical simulations for each province estimate the amount by which the statutory rates have increased average provincial farm land prices. Taking the differences in these values over time, the increased potential value of land sales per acre for a typical landowner may be determined. Tables 10 - 12 give these values so derived for each province for land sales over the 1970's. For example, from Table 10, landowners in Manitoba who purchased land in 1965 could have sold it in 1972 for an additional $7.31 per acre directly related to the capitalization of the statutory rates into farm land prices.

TABLE 9

Gini Ratios of Percentage of Farms to Percentage of Farm Land Ownership in the Prairie Provinces.

Year	Manitoba	Saskatchewan	Alberta
1961	0.36	0.36	0.46
1966	0.38	0.37	0.46
1971	0.38	0.37	0.46
1976	0.37	0.36	0.47

TABLE 10

Differences In Land Prices Between Year Of Purchase And Sale Directly Related To The Statutory Rates in Manitoba ($/acres)

Year of Purchase	Year of Sale									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1961	6.45	7.46	8.52	10.06	11.98	14.14	16.64	19.59	23.31	27.39
1962	6.19	7.19	8.26	9.79	11.71	13.87	16.37	19.33	23.04	27.13
1963	5.93	6.94	8.00	9.53	11.45	13.61	16.12	19.07	22.78	26.87
1964	5.62	6.63	7.69	9.23	11.15	13.30	15.81	18.76	22.47	26.56
1965	5.24	6.25	7.31	8.85	10.77	12.93	15.43	18.38	22.10	26.18
1966	4.74	5.75	6.81	8.35	10.27	12.43	14.93	17.88	21.60	25.68
1967	4.28	5.29	6.35	7.89	9.81	11.96	14.47	17.42	21.13	25.22
1968	3.43	4.43	5.50	7.03	8.95	11.11	13.61	16.56	20.28	24.36
1969	1.44	2.44	3.51	5.04	6.96	9.12	11.62	14.57	18.29	22.37
1970		1.01	2.07	3.61	5.53	7.69	10.19	13.14	16.85	20.94
1971			1.06	2.60	4.52	6.68	9.18	12.13	15.85	19.93
1972				1.54	3.46	5.61	8.12	11.07	14.78	18.87
1973					1.92	4.08	6.58	9.53	13.25	17.33
1974						2.16	4.66	7.61	11.33	15.41
1975							2.50	5.45	9.17	13.25
1976								2.95	6.67	10.75
1977									3.72	7.80
1978										4.08

TABLE 11

Differences In Land Prices Between Year Of Purchase And Sale Directly Related To The Statutory Rates in Saskatchewan ($/acre)

Year of Purchase	Year of Sale									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1961	7.08	8.34	9.75	11.85	14.52	17.74	21.57	26.04	31.43	37.81
1962	6.83	8.09	9.50	11.55	14.26	17.48	21.13	25.79	31.17	37.55
1963	6.53	7.79	9.20	11.26	13.97	17.19	21.02	25.49	30.88	37.26
1964	6.19	7.45	8.86	10.91	13.62	16.84	20.67	25.14	30.53	36.91
1965	5.73	6.99	8.40	10.45	13.16	16.38	20.21	24.69	30.08	36.45
1966	5.16	6.42	7.83	9.88	12.59	15.81	19.64	24.12	29.51	35.88
1967	4.56	5.82	7.23	9.28	11.99	15.21	19.04	23.51	28.90	35.28
1968	3.51	4.77	6.18	8.23	10.95	14.17	18.00	22.47	27.86	34.24
1969	1.78	3.04	4.45	6.50	9.22	12.44	16.27	20.74	26.13	32.51
1970		1.26	2.67	4.73	7.44	10.66	14.49	18.96	24.35	30.73
1971			1.41	3.46	6.17	9.39	13.22	17.70	23.09	29.46
1972				2.06	4.77	7.99	11.82	16.29	21.68	28.06
1973					2.71	5.93	9.76	14.23	19.62	26.00
1974						3.22	7.05	11.52	16.91	23.29
1975							3.83	8.31	13.69	20.07
1976								4.48	9.86	16.24
1977									5.39	11.77
1978										6.38

TABLE 12

Differences In Land Prices Between Year Of Purchase And Sale Directly Related To The Statutory Rates in Alberta ($/acre)

Year of Purchase	Year of Sale									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1961	12.12	14.18	16.63	20.71	26.28	33.40	41.50	51.24	63.72	79.56
1962	11.69	13.76	16.21	20.28	25.85	32.98	41.07	50.81	63.30	79.14
1963	11.17	13.23	15.69	19.76	25.33	32.46	40.55	50.29	62.78	78.61
1964	10.54	12.60	15.05	19.12	24.70	31.82	39.92	49.66	62.14	77.98
1965	9.79	11.86	14.31	18.38	23.95	31.08	39.17	48.91	61.40	77.24
1966	8.89	10.95	13.40	17.48	23.05	30.18	38.27	48.01	60.49	76.33
1967	7.85	9.91	12.37	16.44	22.01	29.14	37.23	46.97	59.46	75.29
1968	6.05	8.11	10.56	14.64	20.21	27.34	35.43	45.17	57.65	73.49
1969	3.55	5.62	8.07	12.14	17.71	24.84	32.93	42.67	55.16	71.00
1970		2.06	4.51	8.58	14.15	21.28	29.37	39.11	51.60	67.44
1971			2.45	6.52	12.09	19.22	27.31	37.05	49.54	65.38
1972				4.07	9.64	16.77	24.86	34.60	47.09	62.93
1973					5.57	12.70	20.79	30.53	43.02	58.86
1974						7.13	15.22	24.96	37.45	53.29
1975							8.09	17.83	30.32	46.16
1976								9.74	22.23	38.07
1977									12.49	28.33
1978										15.84

Both improved and unimproved farm land is incorporated into the average provincial farm land prices. Consequently, these prices are low compared to average prices of cultivated land. But, the same relative impact on the price of cultivated land may be expected as a result of the statutory rates. Therefore, the numbers recorded in Tables 10 - 12, should really be considered in a relative sense. For example, from Table 10, if land in Manitoba had been purchased in 1961 and sold in 1979, $27.39 per acre of the price could be attributed to the statutory rates. But, this is based on an average farm land price of $218 per acre in 1979. Therefore, on cultivated land valued at $600 per acre, one could expect $76 per acre to be attributed to the statutory rates. Similarily, land valued at $600 per acre in Saskatchewan and Alberta, purchased in 1961 and sold in 1979, would have $102 per acre and $168 per acre, respectively, directly related to the capitalization of the statutory rates into farm land prices.

As well as indicating the potential increases in land sales, Tables 10 - 12 also demonstrate the premium placed on the purchase price of farm land created by the statutory rates. This premium has to be absorbed by investors in order for landowners to realize the increase in wealth. Potential farm land investors are generally established farmers or new entrants. The rising farm land prices caused by the statutory rates affect these two categories of investors differently. The net worth, and therefore the collateral, of an established farmer increases as farm land prices rise. Therefore, if such a farmer chooses to expand his land base he has the increased borrowing capacity to do so. At the same time, to the entrant, or beginning farmer, with no collateral in

land, such increasing farm land prices decrease his ability to compete in the market. This occurs because downpayments and mortgage payments rise as farm land prices rise. Therefore, both categories of investors are adversely affected by rising farm land prices but, established farmers are compensated to the extent their equity also increases. Consequently, the increase in farm land prices caused by the statutory rates has created a redistribution of wealth in favour of the established farmer who already owns a considerable amount of land.

Acreages of farm land transacted in Manitoba in 1971 and 1976 amounted to 868 and 1205 thousand acres, respectively. Assuming the land was purchased prior to 1961, Table 10 reveals $7.46 and $16.64 per acre can be attributed to the statutory rates in 1971 and 1976, respectively. Assuming acquisition of these lands occurred before 1961, the landowners selling the land realized an increase in wealth of $6.5 and $20 million in 1971 and 1976, respectively, as a result of the statutory rates. If such sales occurred in an even distribution across farms, the distribution of these benefits of the statutory rates among farms can be determined from Figure 13. Of the 6.5 million dollars of benefits in 1971, one-half the farms receive $1.625 million and an additional one-fourth of the farms receive $1.625 million and the final one-fourth of the farms receive $3.25 million. Similarily, of the 20 million dollars of benefits in 1976, one-half the farms receive $5 million, an additional one-fourth of the farms receive $5 million and the final one-fourth of the farms receive $10 million. In all the Prairie provinces, the quarter of the total number of farms controlling half of the farm land are farms with an average size of greater than 760 acres. Conse-

quently, the increase in farm land prices caused by the statutory rates has created a redistribution of wealth in favour of the established farmer who already owns a considerable amount of land. That is, in favour of larger farms.

In order to maintain the statutory rates in face of rising costs, the railways have absorbed some of the additional costs of transportation. Public funds have also been used to offset some of the shortfall. Using the difference estimated between the statutory and compensatory rates and applying it to total producer marketings from the Prairies indicates the value of price supports provided to producers. Table 13 presents these values for selected years across the Prairies. The estimates indicate taxpayers and the railways have absorbed costs in the range of $1.9 billion to maintain the statutory freight rates over the period from 1961 to 1978. At the same time, the estimated increase in farm real estate values is $7 billion in the Prairies over the period from 1961 to 1979 as a result of those rates. Therefore, a transfer of funds from the railways and taxpayers in favour of landowners has occurred.

TABLE 13

Value Of Price Supports Provided To Producers
Through The Statutory Rates

	MANITOBA ($m)	SASKATCHEWAN ($m)	ALBERTA ($m)	PRAIRIES ($m)
1964	4.3	23.0	11.3	38.6
1969	6.4	33.8	18.4	58.6
1974	16.0	91.1	47.7	154.8
1978	31.8	157.1	77.9	266.8
1961-78	210.0	1147.0	570.0	1927.0

In summary, taxpayers and the railways absorbed substantial costs in order to maintain the statutory freight rates. At the same time, the benefits of the rates have been capitalized into farm land prices. Consequently, the farm land market in the Prairie provinces has been altered. Rates of return to farm land have been increased and current landowners benefit in terms of increased wealth. Entrants to the farm land market must absorb higher entrance fees but, are compensated with higher returns than normal in the farm land market. The problem becomes determining how compensatory grain freight rates can be charged without resulting in the transitional losses which current landowners would suffer since rates of returns to farm land would fall.[36]

Projected farm land prices are examined under three assumptions regarding future grain freight rates. To do so, the fallow/stubble model and the fertilizer application rate model are estimated to forecast input useage. The results of these models are examined before proceeding with simulations of future farm land prices.

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[36]This problem of termination of many government programs is addressed by G.Tullock, "The transitional gains trap", in The Bell Journal of Economics, Autumn 1975, Vol.6, No.2, pp.671-678.

4.5 PROJECTIONS OF INPUT USEAGE

4.5.1 Fallow/Stubble Acreage Model

The fallow/stubble acreage model is derived to determine projected acreage levels. Two equations are estimated for each province using ordinary least squares. The first equation estimates the ratio of summerfallow acreage to crop acreage seeded on stubble land. The second equation estimates the total acreage seeded to crop.

Table 14 presents the equations estimated to describe the relationship between summerfallow and stubble acreages. On average, over the period of analysis, from 1962 to 1979, for every 100 acres of crop seeded to stubble there has been 62, 329 and 106 acres of summerfallow in Manitoba, Saskatchewan and Alberta, respectively. The specification accounts for significant variations in this ratio over time. The parameter on the TIME variable has the expected negative sign in Manitoba and Alberta. In each year, this ratio declines by 0.03 and 0.02 in Manitoba and Alberta, respectively, once the influence of the LIFT program is removed. Therefore, in Manitoba in each year, for every 100 acres of crop seeded on stubble seedbed, summerfallow acreage declined by 3 acres. No trend could be identified in Saskatchewan. In any year, the intercept value is an estimate of the average value of the ratio once the effects of the LIFT program are removed. Therefore, for Saskatchewan, the projected levels of the ratio are taken as equal to the intercept, 2.57. That is, on average with the effect of the LIFT program removed, for every 100 acres of crop seeded on stubble seedbed in Saskatchewan, there is 257 acres of summerfallow. The LIFT program in 1970 had substantial impacts on the ratio in each province. For every 100

TABLE 14

Summerfallow to Stubble Acreage
Equation Results

	MANITOBA	SASKATCHEWAN	ALBERTA
Intercept (c0)	0.82 (0.11)[a]	2.57 (0.12)[a]	1.17 (0.36)[a]
TIME (c1)	-0.03 (0.004)[a]	-	-0.02 (0.007)[a]
LIFT1 (c2)	0.66 (0.09)[a]	8.41 (0.50)[a]	0.87 (0.15)[a]
LIFT2 (c3)	0.12 (0.09)[ns]	4.55 (0.50)[a]	0.37 (0.15)[b]
Adjusted R^2	0.86	0.95	0.73
F-Ratio	37.18[a]	176.03[a]	16.18[a]
L.H.S. Mean	0.62	3.29	1.06
S.E.	0.09	0.48	0.15

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level.

acres of crop seeded on stubble, summerfallow acreages were increased by 66, 841 and 87 acres in Manitoba, Saskatchewan and Alberta, respectively. An additional impact was felt in Saskatchewan and Alberta in the following year. In 1971, summerfallow acreages were increased by an additional 455 and 37 acres for every 100 acres of crop seeded on stubble land in Saskatchewan and Alberta, respectively. Projected levels of the ratio for Manitoba and Alberta are determined from the constant levels of 0.824 and 1.171, respectively, decreased by 0.03 and 0.02, respectively, per year beginning in 1962.

Other stubble/fallow specifications including variables such as expected crop cash flow and grain inventory were estimated, however, no statistical relationship was evident. The declining area of land fallowed in Manitoba and Alberta is attributed to farmers adopting a more intensive cropping system as they gain the management expertise and confidence to utilize different technologies. Therefore, the presence or absence of statutory grain rates would have minimal influence on summerfallow practises.

The results of the equations explaining the movement in total cultivated acreage are given in Table 15. The only significant variable in the estimation of cultivated acreages is the previous years' level. Since the intercept values are insignificant in each equation estimated, projected crop land acreages could have been taken as equal to those levels in 1979. In Manitoba and Alberta, cultivated acreage is estimated to be equal to the level in the previous year plus a growth factor

TABLE 15

Cultivated Acreage
Equation Results

	MANITOBA	SASKATCHEWAN	ALBERTA
Intercept (d0)	41.29 (291.42)^{ns}	1295.00 (1261.0)^{ns}	155.74 (770.76)^{ns}
Lagged Crop Land Acreage (d1)	1.00 (0.04)^{a}	0.95 (0.05)^{a}	1.00 (0.06)^{a}
LIFT1 (d2)	37.95 (89.82)^{ns}	-41.38 (188.62)^{ns}	-63.40 (149.75)^{ns}
LIFT2 (d3)	38.73 (97.20)^{ns}	-320.32 (326.10)^{ns}	-67.57 (177.11)^{ns}
Adjusted R^2	0.98	0.99	0.96
F-Ratio	270.41^{a}	385.34^{a}	156.00^{a}
L.H.S. Mean	7481.7	23825.0	13854.0
S.E.	85.77	178.21	144.55

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level

of 41 and 156 acres per year measured by the intercept. In Saskatchewan, cultivated acreage is estimated to be 95 percent of the previous year's level plus 1295 acres. The dummy variables used to incorporate the effects of the LIFT program are insignificant in all three provinces. Given the estimates on the parameters for this model, projected cultivated acreages seeded to stubble and fallow land are determined using Equations 17 and 18.

4.5.2 Fertilizer Application Rate Model

A fertilizer application rate model is used to project future application rates. A separate equation is estimated for each crop seeded to stubble and fallow land using ordinary least squares. The results of this estimation are presented for each province in Appendix B.

The model specification is capable of explaining a significant portion of the variation in the application rates for all crops. Generally, the equations estimating the rates applied to stubble land are more significant. The variable expressing the ratio of the price of the grain under consideration to the price of fertilizer is statistically insignificant in all equations. This would indicate a situation of disequilibrium where most farmers have been increasing their use of fertilizer regardless of the relative prices between crops and fertilizer. That is, at the margin, returns received from increased fertilizer applications outweigh the associated costs. Consequently, the ratio of the price of grain to the price of fertilizer has not been a factor of consideration in fertilizer application rates. The TIME variable reflects the rate of adoption and is the dominant variable in each equa-

tion estimated. The intercept and TIME variable are always significant at the 1 percent level and are thus capable of satisfactorily explaining variations in fertilizer application rates during the 1960's and 1970's. Therefore, the historical fertilizer application rates appear to be unaffected by prices and probably would not have changed substantially if the grain freight rates were higher.

For discussion purposes, one equation, fertilizer applications on wheat seeded on stubble seedbed in Manitoba is examined in detail. This equation is estimated as follows:

$$F = \underset{}{2.6} + \underset{(2.8)}{1.47}*(PGRAIN/PIF) + \underset{(0.3)}{3.8}*TIME \qquad (23)$$

where:

F = fertilizer application rate (lbs./acre),

PGRAIN = price received for wheat ($/bu.),

PIF = price index of fertilizer (1971=100), and

TIME = year (1961=1).

This equation is estimated using 18 observations of annual fertilizer application rates (lbs./acre) from 1961 to 1978. Average application rates over this period has been 36 pounds per acre. As explained previously, the coefficient on the variable representing the ratio of the price of wheat to the price of fertilizer is insignificant. The TIME variable is the predominant explanatory variable. The parameter on this variable implies application rates increased 3.8 pounds per acre over the period of analysis. Projected application rates are therefore taken

to be the constant rate of 2.6 pounds per acre plus an additional 3.8 pounds per acre per year beginning in 1961.

4.6 FUTURE SIMULATIONS

Farm land prices in the Prairie provinces are simulated for the years 1980 to 1990 based upon three scenarios of projected grain freight rates. The 1979 farm land price as the starting point for the simulations and the projected crop cash flow levels for the 1980's are used to estimate future farm land prices. The differences between the forecasted farm land price series should reflect the relative impact various grain transportation rate structures will have upon future farm land prices. The three assumptions on future transportation rates and the procedures adopted to estimate expected crop cash flow levels under these rates were discussed in Chapter III. The results of the provincial simulations are presented in Figures 14 - 16. Values of these land price simulations appear in Appendix B.

Under the first simulation, the statutory rates are assumed to be maintained. Therefore, over the period from 1980 to 1990, expected grain prices are reduced by a fixed transportation charge. Using the 1979 farm land price as the base price and expected crop cash cash flow levels generated, the recursive land price model is used to project land prices to 1990. The farm land prices so generated project 1990 values to be $751, $676 and $754 per acre in Manitoba, Saskatchewan and Alberta, respectively.

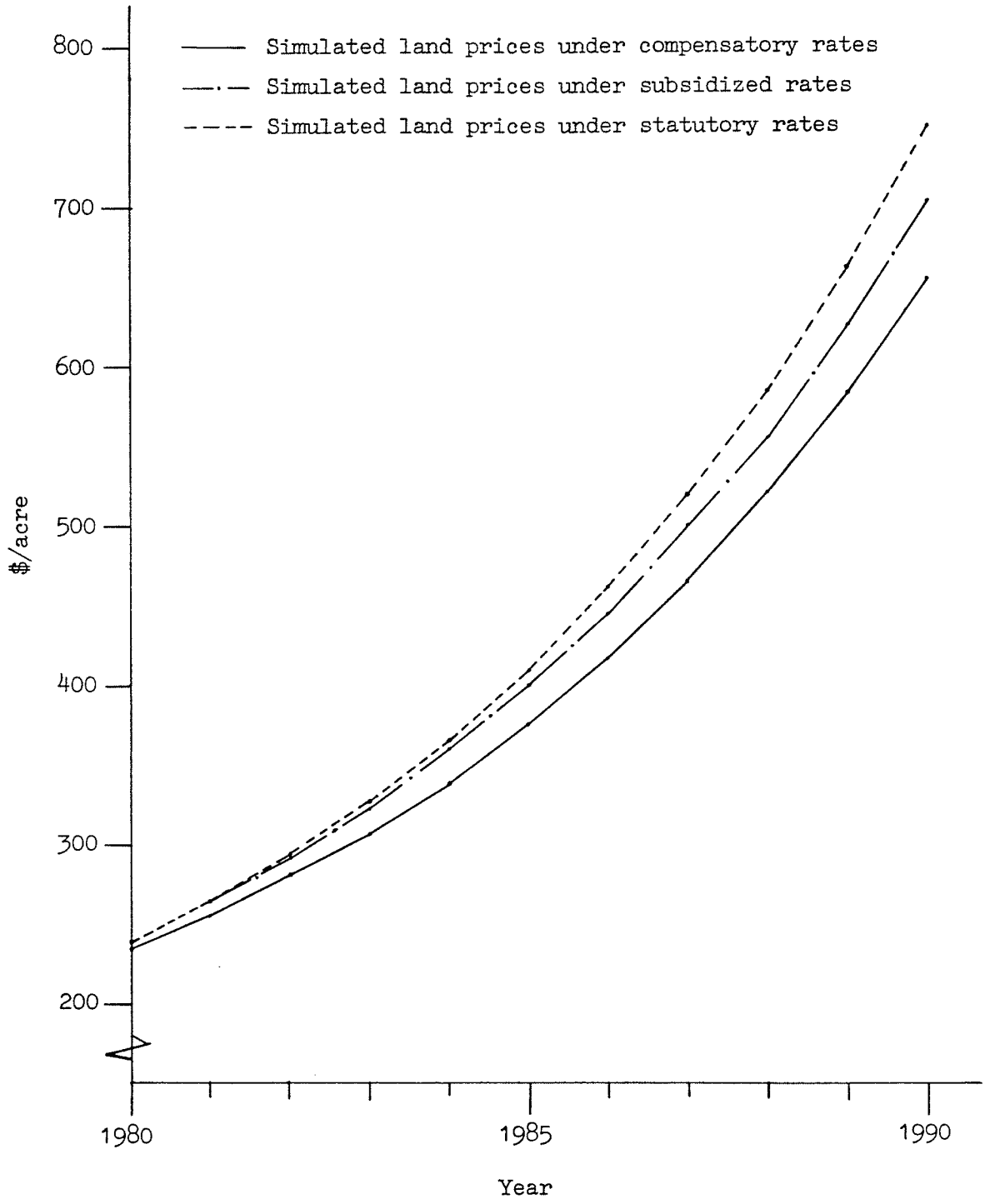


Figure 14

Simulated Land Prices in Manitoba
from 1980 to 1990

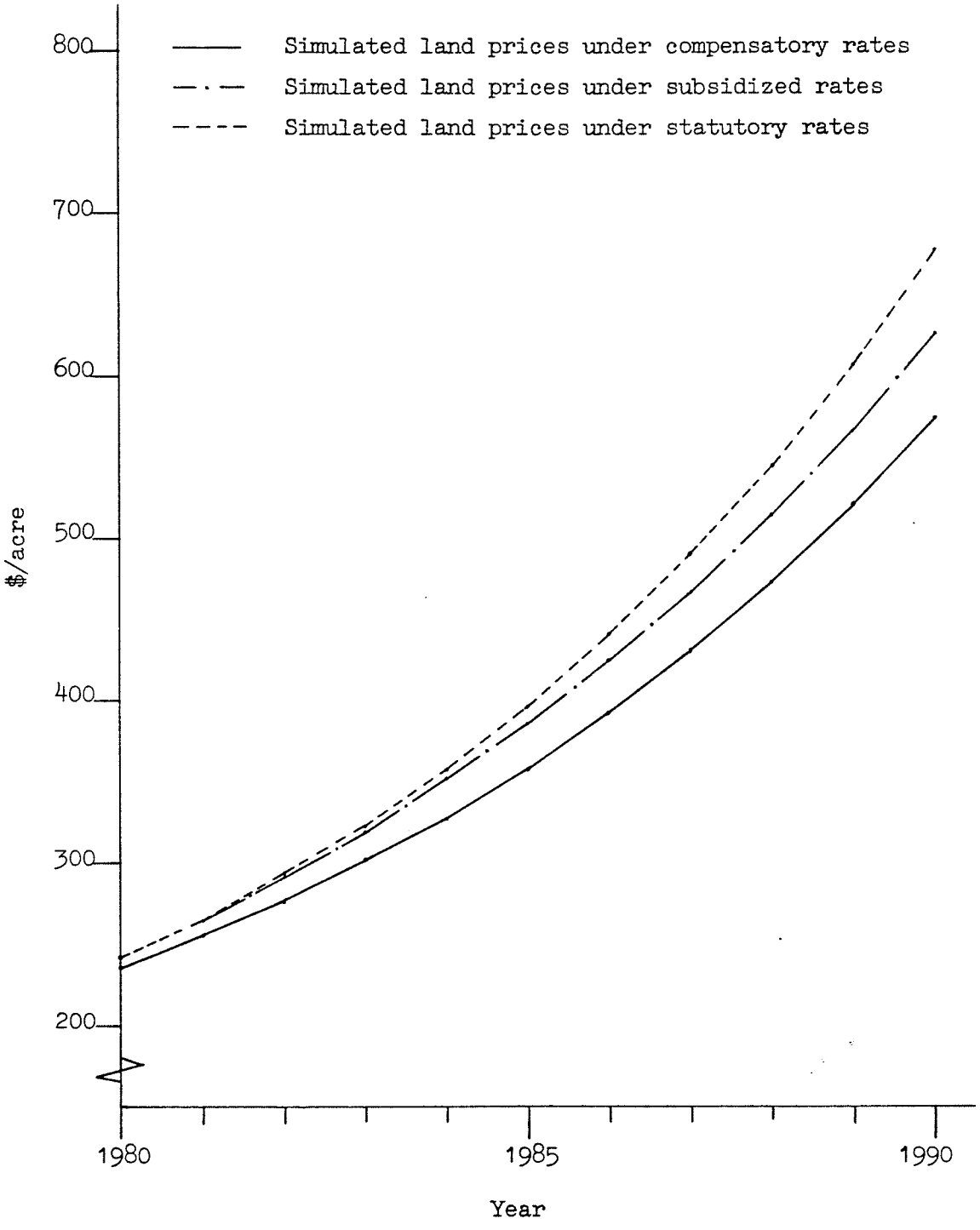


Figure 15

Simulated Land Prices in Saskatchewan
from 1980 to 1990

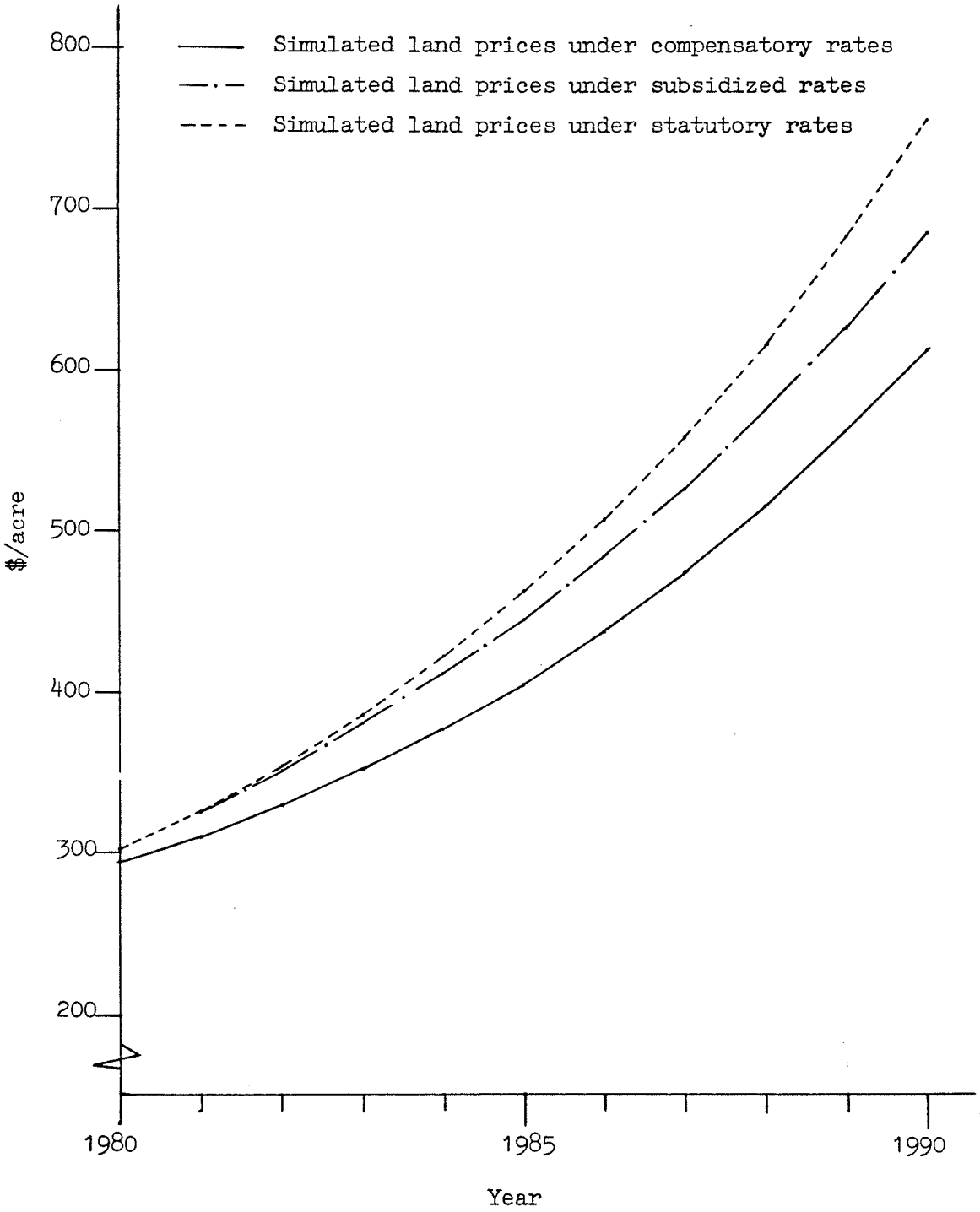


Figure 16

Simulated Land Prices in Alberta
from 1980 to 1990

At the other extreme, farm land prices are projected under the assumption producers must absorb the full cost of compensatory grain freight rates beginning in 1980. These rates are assumed to increase at a compound rate of 11 percent per annum. With a compensatory rate in 1979 required at 3.7 times the statutory rates, this assumption results in grain transportation rates to be 11.6 times the statutory rate by 1990. Therefore, over the period from 1980 to 1990, expected grain prices are reduced by an increasing amount each year to cover rising transportation charges. Again, using the 1979 farm land price as the base price and expected crop cash flow levels generated, the recursive land price model is used to project land prices to 1990. The farm land prices so generated project 1990 values to be $656, $573 and $613 per acre in Manitoba, Saskatchewan and Alberta, respectively.

The difference between the two simulations discussed so far should give an indication of future capitalization rates of the statutory benefits into farm land prices if the rates are maintained. In 1990, these differences amount to $95, $103 and $141 for Manitoba, Saskatchewan and Alberta, respectively. Consequently, if the statutory freight rates are maintained, 13, 15 and 19 percent of the projected 1990 farm land prices in Manitoba, Saskatchewan and Alberta may be directly attributed to these unremunerative rates over the 10 year period. Combined with estimated capitalization rates to 1979, these values increase to 16, 21 and 29 percent to reflect the total anticipated percentage of farm land prices in 1990 attributed to the statutory freight rates.

A third simulation is undertaken to examine the impact of projected farm land prices if producers pay all increases in transportation costs but, the railways are subsidized in each year for the difference between statutory and compensatory rates in 1980. The rates paid by farmers in 1980 would be the same as statutory rates although compensatory rates are 4 times as much. In subsequent years, producers would be required to absorb the additional grain freight costs but, would be subsidized in each year for the 1980 level difference. At some point in the future, as transport costs rise, this subsidization will become negligible relative to total costs. Consequently, producers would absorb virtually the full costs eventually, but a more gradual adjustment to this position would take place. A comparison of the rates under this scenario, versus the one where producers would absorb the full cost starting in 1980, demonstrates this fact. In 1980, the rates are one-quarter what full compensation with no subsidy would require. The rates under the subsidization scheme rises to 8.5 times the statutory rates by 1990. This represents 75 percent of full compensation rates.

Beginning with statutory freight rates in 1980, costs under this final scenario increase by 15 percent in the first year. Rates in subsequent years increase but at a decreasing rate to eventually approach a compound rate of 11 percent per annum. Expected crop cash flows are generated to accomodate this rate structure. Using these values and the 1979 farm land prices, the recursive land price model is again used to project land prices to 1990. The farm land prices so generated project 1990 values to be $704, $625 and $683 for Manitoba, Saskatchewan and Alberta, respectively.

A comparison of this final scenario to the previous ones gives a measure of the comparative magnitude of the impacts on farm land prices resulting from the alternate rate structures. The subsidization scheme serves as a means of transition from statutory rates to compensatory rates. This is also reflected in the projected farm land prices. In the initial years there is minimal difference between land prices under statutory rates and the subsidized rates. Greater differences develop as the subsidized rate approach compensatory levels. Meanwhile, during the transition of the rates, the benefits of the subsidization become capitalized into farm land prices. Consequently, even though land prices in 1990 are suppressed as compared to those under statutory rates, they are still much higher relative to those under full compensatory rates. In fact, in 1990 in all three provinces, the capitalization effects of statutory rates are only reduced by one-half.

Chapter V

SUMMARY AND POLICY IMPLICATIONS

5.1 SUMMARY

The statutory freight rates have been singled out as one of the major contributors to the existing inefficiencies in grain movement in western Canada. Arguments to maintain the rates generally are based on the need for Prairie farmers to effectively compete in world grain markets. Because of the distance to exporting ports, it is argued Prairie farmers cannot pay higher grain freight charges and compete in world grain markets. The statutory rates have caused serious revenue shortfalls for the railways. Such revenue shortfalls have contributed to insufficient reinvestment in the railway grain transportation system. In addition, the rates have been accused of leading to a misallocation of economic resources by discouraging diversification of Prairie agriculture and encouraging the shipment of unimproved agricultural commodities. In light of these developments, an examination of the impact of the statutory freight rates on farm land prices in the Prairie provinces was undertaken.

Given the evidence from previous studies and the relationship shown here, the aggregate supply of the grains hauled under statutory rates are extremely inelastic with respect to prices received by farmers. Therefore, the statutory rates are viewed as a subsidy on farm-gate prices which have a minimal influence upon total grain production.

According to economic theory, whenever an increased income stream is anticipated to be permanent, it will be capitalized into the price of the fixed factor controlling access to the income stream. Since the rates are set by statute, they likely have been perceived by investors to be permanent. Therefore, the higher grain prices created by the rates have increased economic rents, which increases the rate of return to land investments. But, whenever there is an increase in the rate of return to land, the increased bidding for land causes inflated prices since the supply of land is finite. Consequently, the hypothesis was established that the statutory freight rates have increased farm land prices in the Prairie provinces.

Investment theory suggests historical levels of expected annual crop cash flow payments from land should reflect movements in farm land prices. Identification of an approporiate expected crop cash flow stream therefore became crucial to the analysis. Since most investments in farm real estate originate from the family farm unit, expected crop cash flow on a per farm basis was considered the appropriate unit of measure. Farm land prices are specified to be related to expected crop cash flow levels in the current and previous years with declining weights attached to previous levels. From this specification, farm land prices are expressed as a function of present expected crop cash flow payments and farm land prices in the previous year. The long run elasticity of the relationship between crop cash flow and land price is anticipated to equal one, since land prices should appreciate at the same rate as crop cash flow.

Formulation of expected crop cash flow levels required information on crop yields, crop rotations, input useage and transportation charges. To derive historical levels of crop cash flow, a crop yield model is specified to determine expected yield levels. Such a model allows for incorporation of changes in technology over time by accounting for differences in yield potential for crops seeded on stubble and fallow seedbeds, changes in varieties of crop grown, and increases in fertilizer application rates. In addition, the model allows for normalization of weather conditions. Levels of the other components of expected crop cash flow levels are taken as they occurred. Examination of the expected crop cash flow levels so derived reveal variations in the level may be largely accounted for by movements in expected crop prices.

The impacts of technological change and transportation rates on expected crop cash flow levels were examined. The results show by 1979, holding all other factors constant, increased fertilizer application rates can account for 56, 45 and 32 percent of those levels per farm in Manitoba, Saskatchewan and Alberta, respectively. At the same time, increased farm sizes can account for 20 and 14 percent of the levels in Manitoba and Saskatchewan, respectively. In Alberta, it appears the rise in capital expenditures, especially in the final few years, has increased at a faster rate than average farm sizes. Consequently, a problem of over capitalization appears to have developed. Historical expected crop cash flow levels are also derived under compensatory transportation rates. Using required increases in statutory rates in 1974 and 1977 estimated by Snavely as benchmark levels, appropriate price indexes are applied to cost categories of the railways in these

years to derive an index for compensatory rates. Results of the procedure show in order to make the present rate structure compensatory, the rates would have to increase from 1.4 fold in 1961 to 3.7 fold in 1979. In 1979, the results show compensatory rates would have decreased expected crop cash flow levels by 17, 19 and 22 percent in Manitoba, Saskatchewan and Alberta, respectively. Since land prices are expected to accelerate at the same rate as cash flow in the long run, a similar level of impact is anticipated to occur in land prices.

Using the historical expected crop cash flow levels dervied, the land price model was estimated for each province using ordinary least squares. In all three provinces, lagged land price and expected crop cash flow levels explain over 95 percent of the variations in land prices. A one percent increase in expected crop cash flow levels is estimated to result in a 0.09 percent increase in land prices in the short run in all provinces. A one percent increase in lagged land price is estimated to result in a 0.93, 0.95 and 1 percent increase in land prices in the short run in Manitoba, Saskatchewan and Alberta, respectively. The hypothesis that a one percent change in land rent results in a one percent change in land prices could not be rejected. The land price model was then re-estimated with this restriction. Results of this estimation differed marginally from the previous estimation.

Two sets of simulations of land prices were generated over the period of observations from 1961 to 1979. This involved the use of the actual expected crop cash flow levels and those derived using compensatory transportation rates. Given the estimated expected crop cash flow lev-

els under the two sets of transportation rates and the relationships established in the land price model, land prices are simulated using the recursive procedure provided by the land price model. A summary of these results are provided in the next section.

As a final stage, future farm land prices are simulated assuming various transportation policies. In addition to the crop yield model, a fallow/stubble acreage model and a fertilizer application rate model are incorporated to forecast expected crop cash flow levels. These models accounted for decreasing summerfallow acreages and increasing fertilizer application rates. All farm prices and costs are assumed to increase at a compound rate of 10 percent per annum. Levels of other components of expected crop cash flow are generally taken at the 1979 levels. With this information, three series of expected crop cash flow levels are generated for each province differing only in terms of the transportation rate structure adopted. One series represents a continuation of statutory rates, another represents compensatory rates, and a third, a subsidized rate where producers receive the 'crow benefit' realized in 1980. Using the land price model estimated where the elasticity between crop cash flow and farm land prices equalled one, and expected crop cash flow levels derived in the manner discussed, farm land prices are simulated using the three assumptions regarding transportation rates.

5.2 SUMMARY OF RESULTS

An examination of the historical simulations provide for a measurement of the impacts of the statutory freight rates on the farm land market to date. Differences in the two simulations of farm land prices

(with and without statutory rates) reveals 14, 17 and 28 percent of the 1979 farm land values in Manitoba, Saskatchewan and Alberta, respectively, can be attributed to the statutory rates. In terms of total farm land acreages in each province, this implies farm real estate values have increased by $7 billion in the Prairies over the period from 1961 to 1979 as a result of the statutory rates. At the same time, the estimates indicate taxpayers and the railways have absorbed costs in the range of $1.9 billion to maintain the statutory rates over the same period of time. Therefore, it would appear there has been a transfer of funds from the railways and taxpayers to landowners.

To determine how the benefits of the statutory rates have been distributed among farm land owners, the concentration of land ownership over time in the Prairie provinces was examined. The results show the distribution of the benefits of the statutory rates among farms has not changed. It appears half the benefits are received by 25 percent of the farms while the remaining half is divided evenly between another 50 and 25 percent of the farms. Landowners who sold land since the statutory rates became unremunerative have already realized an increase in their wealth since such land sales took place at inflated prices. But, this occurs at the expense of a premium placed on the purchase price of land which has to be absorbed by recent investors. Farm land investors, who consist largely of established farmers or new entrants, are therefore both adversely affected by the rising land prices. But, established farmers are compensated to the extent their equity also increases. Consequently, the increase in farm land values caused by the statutory rates has redistributed wealth in favour of the established farmer who already owns a considerable amount of land.

Farm land prices in the Prairie provinces were also simulated for the years 1980 to 1990 based upon the three scenarios of future transportation rates. The differences between the price series generated indicate the impact various transportation rate structures will have on future farm land prices. A continuation of the statutory rates indicate a continuation of the rate of capitalization of the benefits into farm land prices as has been experienced. The adoption of the subsidized rates serves as a means of transition from statutory to compensatory rates. Meanwhile, during the transition of the rates, the benefits of the subsidization also become capitalized into farm land prices. Consequently, even though land prices in 1990 are suppressed as compared to those under statutory rates, they are still much higher relative to those under full compensatory rates. In fact, in 1990 in all three provinces, the capitalization of the benefits of the statutory rates are only reduced by one-half by using the subsidization scheme.

5.3 LIMITATIONS

The aggregation of data used in this study demand care in interpretation of the results. That is, interpretation should remain on an aggregate basis. All components of the land price model consist of average provincial data. It is well known there is a high degree of variability in factors such as crop yields, fertilizer application rates, cropping patterns, weather conditions, soil types, transportation rates and land prices within each province. Therefore, one would expect there would be significant differences between different areas of the provinces as to the impact statutory freight rates have had on farm land prices.

Nevertheless, the average provincial results should still give an indication of relative impacts.

Average provincial farm land prices from Statistics Canada used in the study incorporate all farm land. Consequently, both improved and unimproved farm land are used in calculating an average price. Therefore, the assumption prices of both improved and unimproved farm land move at the same rate had to be undertaken. Studies are not available as to whether or not a difference exists between these two farm land markets. Therefore, the possible limitations of such an assumption are really unknown.

Calculation of expected crop receipts is limited to the extent the five principal crops grown in the Prairie provinces are taken to be representative of all crops grown. A certain amount of non-statutory crops, especially in Manitoba, are also grown. Expected crop receipts would likely alter if prices and acreages of these non-statutory crops were taken into account.

5.4 POLICY IMPLICATIONS

Present attitudes involving grain transportation in western Canada suggest for a change in the statutory rate structure on grain and grain products. Pressure for such change originated largely from the railways. It became widely recognized and accepted with the Snavely Commission results that the railways have incurred losses in grain traffic. As a result, the railways lack the incentive to give grain traffic the same consideration as other traffic. In addition, they lack the finan-

cial incentive to maintain the transport system for grain traffic. Consequently, the maintenance of the unremunerative rates has resulted in inadequate investment in the grain transportation system. To alleviate the inadequate investment, the federal and provincial governments and the Canadian Wheat Board have financed some capital projects. In addition to these problems, the rates have possibly lead to a misallocation of economic resources as they have discouraged diversification of Prairie agriculture and encouraged the shipment of unprocessed agricultural commodities. Such misallocation of resources both at the farm and regional levels raises serious doubt as to the 'benefits' of the statutory rates.

Numerous compensation schemes have been proposed for changing the grain rate structure. These proposals fall into one of two major categories. Such programs generally advocate direct compensation either to the railways or to the producers. Such proposals have been outlined by Wilson[37] and evaluated based upon economic efficiency criteria. A brief summary of the findings of that study follow.

Direct compensation to the railways is considered by many to be the politically most popular policy. One variation of these proposals calls for an annual payment to be made to the railways from the government. Such a compensation scheme improves the financial situation for the railways but, would increase the financial committment of public funds

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[37] W.W.Wilson and E.W.Tyrchniewicz, The Role Of Transportation In The Development Of Western Canadian Agriculture, a special report prepared for the Canada West Foundation Task Force on the Role of Agriculture in the Economic Development of Western Canada, Department of Agricultural Economics, University of Manitoba, Winnipeg, Manitoba, January, 1980.

and do nothing to alleviate the problems of resource misallocation. A second variation of these proposals suggests the railways to be paid the same amount of compensation in each year, determined in a base year, with increasing costs over time being offset by an increasing freight rate. In this manner, the users of the service would gradually bear a greater portion of grain transport costs. Such proposals would have the effect, over time, of gradually alleviating the problems previously outlined.

A second set of compensation schemes propose for producers to be compensated directly. That is, for freight rates to increase to compensatory levels while grain producers are subsidized directly. Such payments have been advocated on both a volume of grain marketed and land basis. These programs would help remove the problems facing the railways and help alleviate the problems of resource misallocation provided such payments do not continue to be attached to export grain deliveries. But, such programs still involve an income transfer which increases pressure on public funds.

All the above compensation scheme proposals involve either an explicit or implicit subsidy to western grain producers. A popular notion with regards to the statutory freight rates is that the rates may change but, the 'benefits' will be retained by producers. To support such a notion implies the western producer is entitled to reduced rates on the shipment of statutory grains. A closer examination into the purpose of the Crowsnest Pass Agreement provides a better appreciation of the statutory freight rates.

Government intervention into transportation at the time of westward expansion in Canada took the form of subsidies. The Crowsnest Pass Agreement marked the beginning of such intervention. In that agreement, a substantial subsidy was made available to the Canadian Pacific Railway by the Federal Government to establish a rail route through western Canada. In return for this subsidy, CPR agreed upon several concessions to the government. Among these concessions were the Crowsnest Pass grain freight rates. Later legislation made these rates statutory. By forcing the railways to transport grain traffic at legislated rates, the government believed the inherent monopoly power of the railways could be controlled.

Such government intervention was considered necessary for reasons of national interest. The risks involved for a private enterprise to establish a rail route through western Canada were too severe. At the same time, Canada as a nation, could not risk the loss of western Canadian resources to the United States because such a route did not exist. Consequently, this transport subsidy was part of a regional development plan.

The existing environment at the time the rates were established was far different from the present one. Then, transportation was essential to regional development. Now, the transportation system has deteriorated. Ironically, the very concession of reduced grain transportation rates to which CPR agreed has become a major problem. That is, because of unforeseen inflationary pressures, the long run financial costs of such a concession could not be considered at the time of the agreement.

The consequence of the agreement has been the statutory freight rates have protected western grain producers. Dissolution of the rates is viewed by producers as an infringement upon their 'rights'. The question becomes what these 'rights' are and whether they actually exist. With this statute, producers only were ensured grain revenues would be protected to the extent of the potential impact of grain freight rates on farm gate prices. As such, the statute provided protection not rights. It may be argued a producer has rights in terms of use of his farm land. But, even then, according to Wood,[38] in Canada there is no legal foundation to a constitutional right to compensation as a result of land use regulations. Just the same, the statute in question did not affect rights but instead earning capacities. This is directly comparable to the protection provided to certain industries when tariffs are legislated. Such tariffs are established when it is considered of national interest to do so. If circumstances change which alters the need for protection, tariffs are removed. Such industries are not compensated for any expected financial losses because industrial protection is removed. Similarily, the circumstances surrounding the statutory freight rates have changed. If it is deemed no longer of national interest to maintain them and, if the protection they provide producers is no longer considered necessary, they should be changed or dissolved without compensation.

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[38] "Land Use Regulation: Is Compensation Payable?", an abbreviated version of a paper prepared for the Science Council by Denis Wood, a Toronto lawyer in "Study on Population, Technology and Resources, Perceptions 4, People and Agricultural Land" by Charles Beaubien and Ruth Tabacnik, Science Council of Canada, Ottawa, June 1977.

Compensation to producers is also difficult to defend when the results of this study are considered. All proposals for compensation involve either a direct or indirect subsidy to producers and require financing from public funds. In view of the capitalization of such subsidies into farm land values, it is difficult to justify such an income transfer. Also, the statutory rates have contributed to a barrier of entry into the farm land market. Therefore, maintenance of those rates may be in conflict with any policy attempting to ease entry of new farmers into the farm land market.

If compensation takes place, it should be done in a manner which will circumvent the capitalization problem discussed in this study. Full compensation will require payment of the full difference between statutory and compensatory freight rates over a specified period of time. Any proposal which advocates direct compensation to the railways will continue to perpetuate the capitalization problem as producers will continue to realize an increased income stream from land investments. Producers must be forced to incur full compensatory rates and receive compensation in a manner which is not attached to either the volume of grain marketed or acreage of landownership. That is, compensation must be linked to individuals not grain or land. In this manner, new entrants will be excluded from such payments. In addition, this compensation should take the form of a lump sum payment in order to ensure the recipients view it as a windfall gain and not as income attached to the earning capacity of farm land.

Based on the analysis in this study, an estimation of the magnitude of such a lump sum payment is calculated. This calculation is performed by taking the estimated difference between compensatory and statutory rates over a ten-year time span, multiplied by the estimated traffic volume in each of the three Prairie provinces and discounted at a rate of 12 percent per annum. This procedure estimates a lump sum payment of $4340 million in total to the Prairie provinces in 1980. In order to account for differences in transport distance and production levels between these provinces, it would be most expedient to pay each province their share of this payment and allow them to decide upon the manner in which it would be distributed. These shares are calculated to be $560 million to Manitoba, $2246 million to Saskatchewan and $1534 million to Alberta. If the provinces choose to distribute this payment among farmers based upon their landownership, two factors must be considered. First, distribution should be done in a manner which accounts for differences in the grain productive capability of farm land, such as determined by the provincial crop insurance corporations. Secondly, an upper limit should be placed upon the amount any individual receives in order to ensure a certain degree of equity.

Earlier, a comparison was made between the statutory freight rates and the establishment of a tariff. Removal of tariff protection is often done in a gradual manner to ease the transition to no protection. A case could be argued for a similar removal of the statutory rates. This could be achieved if producers were gradually forced to pay compensatory rates. In this manner, they would incur a larger share of the costs of grain transportation, over time. Similar programs have been

advocated but with the railways receiving the subsidy and producers incurring future increasing rates. But, such a procedure would still lead to capitalization of this subsidy into farm land values. Instead, producers would have to be subsidized and it would have to take the form of a lump sum payment equivalent to the present value of such a program. Using the production and rate estimates of this study, this lump sum payment would be in the order of $2417 million to the Prairie provinces in 1980. Provincial shares would be $312 million for Manitoba, $1252 million for Saskatchewan and $853 million for Alberta. This procedure gradually narrows the gap between statutory and compensatory rates but, only on future rates to any significant degree. Consequently, present values of required subsidies are still fairly substantial since values of more current years have a greater impact. This approach could be advocated on the principle of providing ease in the transition away from protection but, consideration should be given to the choice in timing if such a procedure were adopted. Those advocating the abolishment of statutory rates likely support the view they should have been removed a number of years ago. If this view is taken, the subsidies producers have received over the last few years may be considered sufficient 'compensation' for removal of the statutory rates at the present time.

5.5 SUGGESTIONS FOR FURTHER RESEARCH

A similar investigation on a disaggregate basis could provide additional useful information. Examination of the farm land market on a crop district basis could help to account for the high degree of variability in crop yields, fertilizer application rates, cropping patterns,

weather conditions, soil types, transportation rates and land prices within each province. In addition, incorporation of prices and acreages of non-statutory crops would improve this analysis. This would be especially important in crop districts where the proportion of non-statutory crops is fairly high relative to the provincial average.

A more useful approach for further investigation may result by examining specific farming enterprises of various sizes. On an aggregate provincial basis, the supply of statutory crops was argued to be highly price inelastic. Although such an argument could be defended in an aggregate sense, there is likely a certain degree of crop substitution which occurs in individual enterprises. As a result, the impact of the statutory freight rates likely has a differential impact upon land prices depending upon the size and types of farm enterprises predominant in any area being examined.

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Appendix A

DATA

TABLE A.1

Farm Land Acreages in the Prairie Provinces
('000 acres)

Year	Manitoba	Saskatchewan	Alberta
1961	18170	64416	47229
1962	18353	64614	47580
1963	18536	64813	47930
1964	18718	65012	48281
1965	18901	65211	48632
1966	19084	65409	48983
1967	19069	65339	49088
1968	19054	65268	49192
1969	19039	65198	49297
1970	19023	65127	49402
1971	19008	65057	49506
1972	19012	65148	49591
1973	19016	65239	49675
1974	19019	65330	49760
1975	19023	65421	49844
1976	19026	65511	49929
1977	19030	65602	50013
1978	19033	65693	50098
1979	19037	65784	50182

TABLE A.2

Average Farm Sizes in the Prairie Provinces
(acres/farm)

Year	Manitoba	Saskatchewan	Alberta
1961	420	686	645
1962	432	701	657
1963	444	717	669
1964	456	732	682
1965	468	748	694
1966	480	763	706
1967	493	779	723
1968	505	796	740
1969	518	812	756
1970	530	829	773
1971	543	845	790
1972	553	861	795
1973	563	876	801
1974	573	892	806
1975	583	907	812
1976	593	923	817
1977	612	929	822
1978	631	935	827
1979	650	941	832

TABLE A.3

Crop Land Acreages Seeded to Stubble and Fallow Seedbeds in the Prairie Provinces ('000 acres)

Year	Manitoba		Saskatchewan		Alberta	
	Stubble	Fallow	Stubble	Fallow	Stubble	Fallow
1961	3114	3393	6244	16100	5103	7400
1962	3417	3230	5592	17180	5109	7450
1963	3484	3165	6204	17082	5688	7576
1964	3875	3238	6677	16898	6609	7053
1965	4288	2848	7105	16940	6773	6837
1966	4542	2900	8479	16800	7133	7071
1967	4880	2669	8998	15896	7682	6659
1968	4982	2650	7845	16370	7854	6567
1969	4442	2655	7578	17138	7065	6531
1970	3185	3279	2070	16726	4740	7401
1971	3897	4000	2325	22735	5177	8900
1972	4937	2655	6513	16560	6842	7009
1973	5031	2900	5825	18500	6997	7181
1974	5171	2500	6378	17200	6824	6800
1975	5010	2700	5330	17900	6675	7300
1976	5342	2600	5424	18200	7421	6895
1977	5832	2308	6350	17759	7626	6500
1978	6299	2267	7448	17613	8135	7000
1979	6622	2000	8300	17000	9045	6300

TABLE A.4

Tame Hay Acreages, Average Yields and Average Prices
in the Prairie Provinces
('000 acres, tons/acre, $/ton)

Year	Manitoba			Saskatchewan			Alberta		
	Acres	Yield	Price	Acres	Yield	Price	Acres	Yield	Price
1961	934	1.72	12.9	1010	1.56	14.6	2200	1.45	16.0
1962	1004	0.90	17.5	1052	0.66	19.0	2477	1.28	20.0
1963	1045	2.00	14.0	1052	1.52	15.5	2626	1.52	17.0
1964	1020	1.83	15.0	1110	1.70	14.0	2600	1.48	16.0
1965	990	1.48	16.0	1165	1.06	17.0	2652	1.37	19.0
1966	960	1.70	16.5	1190	1.87	16.0	2864	1.94	16.0
1967	1065	1.97	16.5	1246	1.71	16.0	2938	1.61	16.5
1968	1052	1.52	17.5	1100	1.11	19.0	2875	1.39	20.0
1969	940	1.70	18.5	1100	1.18	21.5	2740	1.17	24.7
1970	1000	1.90	16.5	1200	1.39	21.0	2900	1.37	22.3
1971	1160	1.92	15.0	1600	1.75	20.0	3400	1.82	20.0
1972	1084	1.94	16.5	1646	1.52	21.0	2959	1.67	21.5
1973	1200	1.67	20.0	1800	1.39	20.9	3100	1.77	21.3
1974	1200	1.83	30.0	1900	1.53	31.0	3200	1.78	36.0
1975	1250	1.92	35.0	2000	1.60	40.0	3350	1.82	41.1
1976	1250	2.00	37.0	2000	1.70	39.8	3300	1.76	42.5
1977	1400	1.86	37.5	2200	1.55	42.5	3800	1.63	47.5
1978	1400	1.86	37.5	2150	1.40	44.9	3700	1.73	52.4
1979	1400	2.07	37.5	2100	1.81	44.4	3600	2.06	51.3

TABLE A.5

Crop Operating Expenses and Depreciation Charges on Machinery in the Prairie Provinces ($'000)

Year	Manitoba		Saskatchewan		Alberta	
	Operating Expenses	Machinery Deprn	Operating Expenses	Machinery Deprn	Operating Expenses	Machinery Deprn
1961	96416	30369	226111	77200	210780	61970
1962	104325	31093	239288	78171	222230	64533
1963	111416	32959	259130	83308	236774	68158
1964	121527	35703	285012	91612	258454	73888
1965	130643	38837	310396	102288	275392	80809
1966	147803	42254	334539	114538	298962	89184
1967	159094	46213	353612	123258	327311	96358
1968	175148	49417	379900	129626	354302	103030
1969	166842	50369	380526	130304	292319	104949
1970	164763	50227	349054	127083	357848	106856
1971	164438	48552	345915	121124	349931	104264
1972	175765	50039	378253	127088	383143	108816
1973	209018	54032	438393	140807	465505	118881
1974	270233	70207	549128	184625	603833	155133
1975	324863	95769	627253	253370	713035	212039
1976	375086	118794	760992	318503	808737	262757
1977	421876	130818	830813	304011	827101	295068
1978	520229	146999	990846	398049	967361	332626
1979	585248	166530	1091282	447120	1120785	376408

TABLE A.6

Distribution of the Five Principal Crops Grown in Manitoba on Stubble Seedbed (percentage)

Year	Wheat	Oats	Barley	Rape	Flax
1961	17.37	48.62	13.6	0.23	20.17
1962	24.83	46.19	13.12	0.44	15.42
1963	24.62	42.70	11.63	0.62	20.44
1964	25.82	39.66	9.60	1.27	23.65
1965	27.45	32.54	10.30	2.12	27.60
1966	25.74	33.56	14.33	2.83	23.53
1967	33.01	33.51	17.46	2.30	13.72
1968	30.65	32.06	20.20	1.42	15.67
1969	18.12	34.97	20.23	2.94	23.74
1970	9.12	34.32	26.01	5.20	25.34
1971	14.76	33.63	32.63	6.22	12.77
1972	23.61	24.09	37.10	5.70	9.50
1973	25.08	24.77	34.80	4.86	10.49
1974	28.70	22.79	30.02	6.04	12.44
1975	29.98	20.89	25.59	10.39	13.15
1976	40.16	21.75	26.78	2.64	8.67
1977	34.65	17.40	30.21	5.79	11.94
1978	37.19	11.41	27.26	12.77	11.37
1979	35.50	6.57	22.07	16.65	19.20

TABLE A.7

Distribution of the Five Principal Crops Grown in Manitoba on Fallow Seedbed (percentage)

Year	Wheat	Oats	Barley	Rape	Flax
1961	69.57	14.72	8.60	0.65	6.46
1962	72.06	13.28	7.50	0.59	6.56
1963	76.33	9.63	7.18	0.83	6.03
1964	77.65	8.92	5.29	1.27	6.87
1965	75.05	7.72	6.60	2.11	8.53
1966	76.93	5.75	10.17	1.92	5.23
1967	80.14	6.59	8.60	1.78	2.88
1968	77.82	5.95	10.42	1.07	4.73
1969	67.28	6.90	15.75	3.10	6.98
1970	41.85	9.04	27.04	9.11	12.96
1971	53.42	7.40	25.55	9.87	3.76
1972	61.77	4.85	20.69	8.85	3.85
1973	67.86	5.19	16.91	6.11	3.93
1974	60.98	6.65	17.71	9.18	5.47
1975	66.19	5.35	12.42	10.46	5.58
1976	72.88	7.16	11.24	4.80	3.92
1977	63.55	6.59	14.95	9.05	5.86
1978	62.14	5.44	11.02	15.86	5.54
1979	52.32	4.16	10.68	24.16	8.68

TABLE A.8

Distribution of the Five Principal Crops Grown in Saskatchewan on Stubble Seedbed (percentage)

Year	Wheat	Oats	Barley	Rape	Flax
1961	50.91	27.98	15.25	1.04	4.82
1962	52.60	28.94	15.03	0.78	2.65
1963	54.01	23.95	17.36	1.07	3.62
1964	64.88	16.28	13.20	1.49	4.15
1965	58.40	19.69	14.89	2.82	4.20
1966	59.10	16.74	17.79	3.58	2.80
1967	65.41	12.84	17.99	2.63	1.13
1968	60.36	16.22	19.19	1.95	2.29
1969	48.57	21.23	21.91	4.18	4.11
1970	18.87	30.48	35.70	8.00	6.96
1971	6.20	40.11	47.21	2.79	3.69
1972	42.88	16.85	35.34	2.41	2.52
1973	39.68	20.57	34.46	2.62	2.67
1974	40.92	20.17	34.39	2.40	2.13
1975	39.75	21.69	33.51	3.14	1.92
1976	50.04	18.60	29.58	0.79	1.00
1977	46.32	16.00	31.20	3.25	3.23
1978	53.29	11.14	26.53	6.46	2.58
1979	60.54	8.32	20.52	6.53	4.09

TABLE A.9

Distribution of the Five Principal Crops Grown in Saskatchewan on Fallow Seedbed (percentage)

Year	Wheat	Oats	Barley	Rape	Flax
1961	80.58	7.18	6.20	1.92	4.13
1962	85.64	7.15	5.00	0.74	1.48
1963	86.92	4.96	5.50	0.87	1.75
1964	90.65	2.89	3.59	1.26	1.61
1965	87.60	3.81	4.66	2.22	1.71
1966	88.01	2.95	5.11	2.68	1.25
1967	89.04	2.78	5.20	2.38	0.62
1968	86.73	3.41	6.33	2.19	1.34
1969	80.47	4.10	7.99	4.39	3.06
1970	51.47	8.50	16.86	13.71	9.46
1971	58.11	5.08	20.79	12.17	3.85
1972	69.07	4.28	15.37	8.24	3.05
1973	73.49	4.54	12.21	7.06	2.71
1974	71.55	4.67	13.56	7.69	2.53
1975	74.42	4.20	10.12	9.27	1.99
1976	83.88	3.52	7.84	3.94	0.82
1977	76.26	3.35	10.95	7.13	2.31
1978	75.68	2.41	7.10	13.28	1.53
1979	72.72	2.04	5.83	16.57	2.84

TABLE A.10

Distribution of the Five Principal Crops Grown in Alberta on Stubble Seedbed (percentage)

Year	Wheat	Oats	Barley	Rape	Flax
1961	24.68	36.17	35.93	1.72	1.51
1962	23.98	37.08	35.88	1.54	1.52
1963	25.05	31.10	40.75	1.57	1.53
1964	28.94	25.41	40.16	3.30	2.18
1965	27.00	26.85	38.12	5.99	2.05
1966	29.61	23.39	40.90	3.89	2.21
1967	26.71	21.61	45.48	5.51	0.70
1968	28.75	20.32	46.93	2.73	1.26
1969	20.05	21.20	51.91	4.95	1.88
1970	5.66	27.92	59.11	6.37	0.95
1971	9.35	24.78	58.32	7.17	0.38
1972	16.67	21.26	55.38	6.22	0.46
1973	14.78	22.17	56.71	5.86	0.47
1974	13.51	19.40	60.33	6.11	0.65
1975	12.20	22.80	58.16	6.27	0.57
1976	21.68	17.85	57.29	3.00	0.19
1977	19.19	15.23	56.75	8.36	0.47
1978	20.97	13.12	50.52	14.97	0.42
1979	24.22	10.48	43.83	20.34	1.13

TABLE A.11

Distribution of the Five Principal Crops Grown in Alberta on Fallow Seedbed (percentage)

Year	Wheat	Oats	Barley	Rape	Flax
1961	60.91	14.45	17.58	3.11	3.96
1962	64.20	13.69	17.01	1.41	3.69
1963	63.62	12.20	19.12	1.97	3.08
1964	68.88	8.18	16.25	3.16	3.53
1965	65.34	8.98	16.65	5.59	3.43
1966	66.60	7.85	17.23	5.37	2.94
1967	68.17	6.65	16.35	7.38	1.45
1968	66.54	7.49	19.19	3.84	2.94
1969	57.79	7.75	22.54	7.17	4.74
1970	32.40	13.06	29.83	16.36	8.35
1971	34.18	9.48	34.64	18.83	2.87
1972	47.84	8.43	28.20	13.47	2.06
1973	53.35	9.17	22.57	12.64	2.28
1974	50.81	8.80	26.09	11.88	2.42
1975	43.03	9.84	28.62	14.90	3.61
1976	59.84	8.23	23.11	7.91	0.91
1977	53.53	7.46	22.73	14.93	1.35
1978	50.14	6.33	16.69	25.86	0.98
1979	50.30	5.76	13.26	28.37	2.30

TABLE A.12

Average Initial and Final Payments and Average Elevation Charges on Candian Wheat Board Grains in the Prairie Provinces ($/bu.)

Year	Wheat Initial Price	Wheat Elevation Charge	Wheat Final Price	Oats Initial Price	Oats Elevation Charge	Oats Final Price
1960	1.34	0.05	0.42	0.56	0.05	0.14
1961	1.50	0.05	0.44	0.56	0.05	0.17
1962	1.39	0.06	0.43	0.56	0.05	0.12
1963	1.43	0.05	0.48	0.55	0.05	0.09
1964	1.38	0.05	0.38	0.55	0.05	0.18
1965	1.44	0.05	0.38	0.56	0.05	0.07
1966	1.43	0.07	0.46	0.55	0.06	0.24
1967	1.66	0.08	0.13	0.61	0.07	0.17
1968	1.53	0.08	0.00	0.58	0.07	0.00
1969	1.53	0.08	0.08	0.60	0.08	0.09
1970	1.40	0.08	0.20	0.55	0.08	0.08
1971	1.42	0.08	0.12	0.56	0.08	0.08
1972	1.77	0.08	0.46	0.66	0.08	0.39
1973	3.74	0.08	0.95	1.05	0.08	0.68
1974	3.48	0.15	0.80	1.13	0.15	0.50
1975	3.70	0.17	0.20	1.14	0.17	0.48
1976	2.96	0.20	0.22	1.15	0.18	0.15
1977	2.89	0.20	0.22	1.15	0.18	0.00
1978	3.40	0.20	0.78	1.18	0.18	0.00
1979	3.35	0.20	----	1.34	0.18	----

TABLE A.12 (cont'd)

Average Initial and Final Payments and Average Elevation Charges on Canadian Wheat Board Grains in the Prairie Provinces ($/bu.)

Year	Initial Price	Barley Elevation Charge	Final Price
1960	0.88	0.05	0.08
1961	0.90	0.05	0.30
1962	0.88	0.06	0.18
1963	0.89	0.05	0.23
1964	0.88	0.05	0.31
1965	0.87	0.05	0.33
1966	0.89	0.07	0.34
1967	0.99	0.08	0.04
1968	0.96	0.08	0.00
1969	0.81	0.08	0.02
1970	0.91	0.08	0.00
1971	0.82	0.08	0.00
1972	0.96	0.08	0.51
1973	2.15	0.08	0.51
1974	2.12	0.15	0.93
1975	1.88	0.17	0.65
1976	1.84	0.20	0.37
1977	1.83	0.20	0.18
1978	1.84	0.20	0.32
1979	1.81	0.20	----

TABLE A.13

Average Price of Rapeseed and Flaxseed
Received in the Prairie Provinces
($/bu.)

Year	Rapeseed		Flaxseed	
	Manitoba	Sask.& Alta.	Manitoba	Sask.& Alta.
1961	2.00	1.97	2.75	2.71
1962	1.80	1.77	3.30	3.26
1963	1.75	1.72	3.00	2.96
1964	2.50	2.47	2.85	2.81
1965	2.70	2.67	2.95	2.91
1966	2.45	2.42	2.69	2.65
1967	2.45	2.42	2.70	2.66
1968	1.90	1.87	3.08	3.04
1969	1.88	1.85	2.84	2.80
1970	2.40	2.37	2.57	2.53
1971	2.35	2.32	2.15	2.11
1972	2.15	2.12	2.00	1.96
1973	3.10	3.07	4.10	4.06
1974	5.84	5.81	9.55	9.51
1975	7.07	7.04	9.56	9.52
1976	5.11	5.08	6.55	6.51
1977	5.82	5.79	6.78	6.74
1978	6.50	6.47	5.00	4.96
1979	6.25	6.22	7.50	7.46

TABLE A.14

Average Rail Freight Rates
($/bu.)

Crop	Manitoba via Thunder Bay from Carberry	Saskatchewan via Vancouver or Thunder Bay from Scott	Alberta via Vancouver from Hanna
Wheat	0.096	0.138	0.138
Oats	0.054	0.078	0.078
Barley	0.077	0.110	0.110
Rapeseed	0.088	0.123	0.123
Flaxseed	0.098	0.137	0.137

TABLE A.15

Rail Cost Categories Used in Calculating
Compensatory Rate Index

Rail Cost Categories	1974 ($m)	1977 ($m)
repair and servicing	29.00	49.56
property taxes	2.38	3.80
road maintenance	29.21	47.79
locomotive fuels	15.10	25.17
labour related expenses	25.31	49.80
loss and damages	1.47	1.68
other expenses	144.89	177.60
total costs	247.36	355.4

Appendix B

RESULTS

TABLE B.1

Crop Yield Model Results
Manitoba
(bushels per acre)

	WHEAT		OATS		BARLEY	
	Stubble	Fallow	Stubble	Fallow	Stubble	Fallow
Intercept Additive b0	2.37 (0.11)[a]	2.85 (0.08)[a]	3.44 (0.08)[a]	3.66 (0.06)[a]	2.77 (0.08)[a]	3.10 (0.08)[a]
CD	0.20 (0.11)[c]	0.19 (0.08)[b]	0.26 (0.09)[a]	0.32 (0.07)[a]	0.29 (0.08)[a]	0.25 (0.07)[a]
Mult	13.09	20.91	40.73	53.61	21.29	28.39
Adjusted	10.37	17.36	31.29	43.96	17.49	24.27
V (b1)	1.00	1.00	1.00	1.00	1.00	1.00
F (b2)	0.22 (0.02)[a]	0.15 (0.02)[a]	0.11 (0.02)[a]	0.07 (0.02)[a]	0.18 (0.02)[a]	0.15 (0.02)[a]
DM1 (b3)	-0.16 (0.02)[a]	-0.12 (0.02)[a]	-0.18 (0.02)[a]	-0.15 (0.02)[a]	-0.16 (0.02)[a]	-0.14 (0.02)[a]
DM2 (b4)	-0.03 (0.02)[c]	-0.03 (0.01)[b]	-0.04 (0.02)[b]	-0.03 (0.01)[b]	-0.01 (0.02)[ns]	-0.004 (0.01)[ns]
EM1	-0.16 (0.08)[b]	-0.11 (0.07)[c]	-0.18 (0.07)[a]	-0.11 (0.06)[b]	-0.19 (0.07)[a]	-0.16 (0.07)[b]
EM2	-0.03 (0.08)[ns]	-0.06 (0.06)[ns]	-0.03 (0.07)[ns]	-0.03 (0.05)[ns]	-0.08 (0.07)[ns]	-0.12 (0.06)[b]
R^2	0.56	0.52	0.60	0.57	0.67	0.59
S.E.	0.28	0.22	0.24	0.29	0.23	0.22
Dur-Wat	2.08	1.92	1.88	2.04	1.93	1.69
NOB	208	208	208	208	208	208

TABLE B.1 (cont'd)

Crop Yield Model Results
Manitoba
(bushels per acre)

	RAPESEED Stubble	FLAXSEED Stubble	FLAXSEED Fallow
Intercept			
Additive			
b0	2.41 (0.14)[a]	2.15 (0.06)[a]	2.28 (0.05)[a]
CD	0.21 (0.06)[a]	0.18 (0.08)[b]	0.32 (0.08)[a]
Mult	13.64	10.28	13.51
Adjusted	13.05	8.99	11.89
V (b1)	-	1.00	1.00
F (b2)	0.07 (0.04)[b]	0.07 (0.01)[a]	0.05 (0.01)[a]
DM1 (b3)	-0.03 (0.02)[b]	-0.14 (0.02)[a]	-0.10 (0.02)[a]
DM2 (b4)	-0.02 (0.01)[ns]	0.004 (0.01)[ns]	-0.17 (0.01)[ns]
EM1	-0.003 (0.06)[ns]	-0.09 (0.06)[ns]	-0.04 (0.06)[ns]
EM2	-0.009 (0.05)[ns]	-0.17 (0.06)[a]	-0.18 (0.05)[a]
R^2	0.57	0.52	0.51
S.E.	0.12	0.21	0.18
Dur-Wat	1.70	1.84	1.99
NOB	117	208	208

TABLE B.1 (cont'd)

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level.

TABLE B.2
Crop Yield Model Results
Saskatchewan
(bushels per acre)

	WHEAT		OATS	
	Stubble	Fallow	Stubble	Fallow
Intercept				
Additive	2.62 (0.05)[a]	3.00 (0.22)[a]	3.42 (0.37)[a]	3.78 (0.21)[a]
Mult	13.76	20.14	30.53	43.66
Adjusted	11.00	17.70	27.34	40.53
V (b1)	1.00	1.00	1.00	1.00
F (b2)	0.17 (0.13)[ns]	0.16 (0.08)[c]	0.17 (0.10)[ns]	0.15 (0.07)[c]
DM1 (b3)	-0.20 (0.09)[c]	-0.20 (0.04)[a]	-0.19 (0.09)[c]	-0.24 (0.05)[a]
DM2 (b4)	0.07 (0.11)[ns]	0.04 (0.05)[ns]	0.10 (0.11)[ns]	0.07 (0.06)[ns]
R^2	0.52	0.77	0.47	0.73
S.E.	0.30	0.15	0.31	0.18
Dur-Wat	1.38	1.87	1.37	1.81
NOB	18	18	18	18

TABLE B.2 (cont'd)

Crop Yield Model Results
Saskatchewan
(bushels per acre)

	BARLEY		FLAXSEED	
	Stubble	Fallow	Stubble	Fallow
Intercept				
Additive	3.09 (0.40)[a]	3.33 (0.28)[a]	2.70 (0.41)[a]	2.86 (0.19)[a]
Mult	21.87	27.92	14.85	17.48
Adjusted	18.46	25.38	9.57	13.26
V (b1)	1.00	1.00	1.00	1.00
F (b2)	0.16 (0.10)[ns]	0.19 (0.09)[c]	0.02 (0.12)[ns]	0.04 (0.08)[ns]
DM1 (b3)	-0.18 (0.09)[c]	-0.23 (0.05)[a]	-0.18 (0.10)[c]	-0.17 (0.05)[a]
DM2 (b4)	0.08 (0.10)[ns]	0.06 (0.06)[ns]	-0.02 (0.15)[ns]	-0.03 (0.06)[ns]
R^2	0.56	0.77	0.47	0.78
S.E.	0.28	0.17	0.31	0.14
Dur-Wat	1.47	1.64	1.76	1.93
NOB	18	18	18	18

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level

TABLE B.3

Crop Yield Model Results
Alberta
(bushels per acre)

	WHEAT		OATS		BARLEY	
	Stubble	Fallow	Stubble	Fallow	Stubble	Fallow
Intercept						
Additive	2.03 (0.27)[a]	2.59 (0.25)[a]	3.55 (0.17)[a]	3.82 (0.10)[a]	3.10 (0.13)[a]	3.35 (0.25)[a]
Mult	7.61	13.34	34.76	45.58	22.20	28.60
Adjusted	7.34	13.75	31.85	49.74	19.21	27.78
V (b1)	1.00	1.00	1.00	1.00	1.00	1.00
F (b2)	0.27 (0.06)[a]	0.23 (0.07)[a]	0.11 (0.04)[b]	0.10 (0.03)[a]	0.14 (0.03)[a]	0.14 (0.07)[c]
DM1 (b3)	-0.08 (0.04)[c]	-0.15 (0.04)[a]	-0.008 (0.04)[ns]	-0.12 (0.02)[a]	0.01 (0.03)[ns]	-0.10 (0.03)[a]
DM2 (b4)	0.04 (0.04)[ns]	0.06 (0.03)[c]	-0.03 (0.04)[ns]	0.04 (0.02)[c]	-0.06 (0.03)[c]	0.02 (0.03)[ns]
R^2	0.76	0.69	0.52	0.80	0.85	0.73
S.E.	0.12	0.10	0.11	0.06	0.08	0.08
Dur-Wat	1.89	1.71	1.70	2.36	2.26	1.74
NOB	18	18	18	18	18	18

TABLE B.3 (cont'd)

Crop Yield Model Results
Alberta
(bushels per acre)

	RAPESEED		FLAXSEED	
	Stubble	Fallow	Stubble	Fallow
Intercept				
Additive	2.76 (0.11)[a]	3.12 (0.06)[a]	2.39 (0.14)[a]	2.76 (0.11)[a]
Mult	15.75	22.6	10.96	15.73
Adjusted	10.94	18.84	9.66	12.99
V	-	-	1.00	1.00
F	0.05 (0.02)[b]	0.005 (0.01)[ns]	0.08 (0.03)[b]	0.08 (0.03)[c]
DM1	0.06 (0.05)[ns]	0.03 (0.03)[ns]	-0.02 (0.05)[ns]	-0.04 (0.04)[ns]
DM2	-0.18 (0.05)[a]	-0.09 (0.02)[a]	-0.03 (0.05)[ns]	-0.07 (0.04)[c]
R^2	0.77	0.60	0.55	0.67
S.E.	0.12	0.07	0.14	0.11
Dur-Wat	2.48	2.59	2.43	2.23
NOB	18	18	18	18

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level.

TABLE B.4

Compensatory Rate Indexing Results

Year	Total Railway Costs (1974 base)	Total Railway Costs (1977 base)	Index (1974 base)	Index (1977 base)	Index (combined)
1961	124.1	139.7	1.38	1.21	1.38
1962	126.4	142.1	1.41	1.23	1.41
1963	129.5	145.6	1.44	1.26	1.44
1964	131.7	148.7	1.46	1.29	1.46
1965	136.1	154.0	1.51	1.34	1.51
1966	141.2	159.9	1.57	1.39	1.57
1967	144.5	163.9	1.61	1.42	1.61
1968	148.1	168.1	1.65	1.46	1.65
1969	155.2	176.3	1.73	1.53	1.73
1970	159.4	181.5	1.77	1.57	1.77
1971	164.1	187.3	1.82	1.62	1.82
1972	174.6	199.3	1.94	1.73	1.94
1973	202.1	229.0	2.25	1.98	2.25
1974	247.4	280.1	2.75	2.43	2.75
1975	270.7	307.5	3.01	2.67	2.84
1976	285.5	324.4	3.17	2.81	2.99
1977	312.8	355.4	3.477	3.08	3.08
1978	338.5	383.7	3.76	3.33	3.33

TABLE B.5

Land Price Results
Manitoba

Year	Actual Price ($/acre)	Simulated Price under Statutory Rates ($/acre)	Simulated Price under Compensatory Rates ($/acre)
1961	54	55	55
1962	55	58	58
1963	59	62	62
1964	66	66	65
1965	75	70	69
1966	82	74	72
1967	91	81	79
1968	97	84	81
1969	90	80	74
1970	84	77	70
1971	83	80	73
1972	83	84	76
1973	95	102	92
1974	121	123	111
1975	138	147	133
1976	161	166	149
1977	172	182	162
1978	198	198	175
1979	218	221	193

TABLE B.6

Land Price Results
Saskatchewan

Year	Actual Price ($/acre)	Simulated Price under Statutory Rates ($/acre)	Simulated Price under Compensatory Rates ($/acre)
1961	37	39	39
1962	40	43	42
1963	47	47	46
1964	55	52	50
1965	66	56	55
1966	76	62	60
1967	84	69	67
1968	86	73	69
1969	76	73	68
1970	70	71	64
1971	69	76	67
1972	69	81	71
1973	80	98	86
1974	100	120	105
1975	130	145	127
1976	158	163	141
1977	166	182	156
1978	192	205	173
1979	223	233	195

TABLE B.7

Land Price Results
Alberta

Year	Actual Price ($/acre)	Simulated Price under Statutory Rates ($/acre)	Simulated Price under Compensatory Rates ($/acre)
1961	51	62	61
1962	54	65	64
1963	59	68	67
1964	66	71	69
1965	76	75	72
1966	84	80	76
1967	94	86	82
1968	102	88	81
1969	100	86	77
1970	95	81	68
1971	93	84	70
1972	94	87	70
1973	106	104	83
1974	136	127	101
1975	166	156	122
1976	183	180	138
1977	190	207	155
1978	205	241	177
1979	284	282	202

TABLE B.8

Projected Simulations of Farm Land Prices
in Manitoba

Year	Simulated Prices under Statutory Rates ($/acre)	Simulated Prices under Subsidized Rates ($/acre)	Simulated Prices under Compensatory Rates ($/acre)
1980	239	239	235
1981	265	264	256
1982	294	292	280
1983	327	324	308
1984	366	360	340
1985	410	400	376
1986	461	447	418
1987	519	499	466
1988	586	559	521
1989	663	627	584
1990	751	704	656

TABLE B.9

Projected Simulations of Farm Land Prices
in Saskatchewan

Year	Simulated Prices under Statutory Rates ($/acre)	Simulated Prices under Subsidized Rates ($/acre)	Simulated Prices under Compensatory Rates ($/acre)
1980	242	242	237
1981	266	265	256
1982	293	291	277
1983	324	320	301
1984	358	351	328
1985	397	386	359
1986	441	435	392
1987	490	468	430
1988	545	515	473
1989	607	567	520
1990	676	626	573

TABLE B.10

Projected Simulations of Farm Land Prices in Alberta

Year	Simulated Prices under Statutory Rates ($/acre)	Simulated Prices under Subsidized Rates ($/acre)	Simulated Prices under Compensatory Rates ($/acre)
1980	303	303	295
1981	327	326	311
1982	355	352	330
1983	386	380	352
1984	422	412	377
1985	462	446	406
1986	508	485	438
1987	559	527	474
1988	616	574	515
1989	681	626	561
1990	754	683	613

TABLE B.11

Fertilizer Application Rate Model Results
Manitoba
(pounds per acre)

	WHEAT		OATS		BARLEY	
	Stubble	Fallow	Stubble	Fallow	Stubble	Fallow
Intercept	-7445.40 (582.9)[a]	-2774.80 (356.5)[a]	-4886.40 (425.6)[a]	-2076.70 (333.96)[a]	-7800.80 (483.8)[a]	-2712.90 (396.8)[a]
PGRAIN/PIF	1.47 (2.81)[ns]	2.46 (1.72)[ns]	9.72 (6.05)[ns]	4.84 (4.75)[ns]	2.64 (3.67)[ns]	3.80 (3.01)[ns]
TIME	3.80 (0.30)[a]	1.42 (0.18)[a]	2.49 (0.22)[a]	1.06 (0.17)[a]	3.98 (0.25)[a]	1.39 (0.20)[a]
Adjusted R^2	0.91	0.79	0.89	0.70	0.94	0.75
F-Ratio	83.49[a]	32.71[a]	71.48[a]	21.31[a]	135.75[a]	26.26[a]
L.H.S. Mean	36.41	17.68	23.83	13.83	35.39	20.58
S.E.	6.50	3.97	4.72	3.70	5.35	4.39
Dur-Wat	1.34	1.30	1.41	1.14	1.50	1.38
NOB	18	18	18	18	18	18

TABLE B.11 (cont'd)

Fertilizer Application Rate Model Results
Manitoba
(pounds per acre)

	RAPESEED		FLAXSEED	
	Stubble	Fallow	Stubble	Fallow
Intercept	-12567.00 (1296.3)[a]	-6655.00 (843.7)[a]	-4467.90 (458.3)[a]	-1606.90 (121.1)[a]
PGRAIN/PIF	-1.30 (4.53)[ns]	0.05 (2.95)[ns]	1.52 (1.17)[ns]	0.51 (0.30)[ns]
TIME	6.40 (0.66)[a]	3.39 (0.43)[a]	2.27 (0.23)[a]	0.82 (0.06)[a]
Adjusted R^2	0.89	0.85	0.86	0.92
F-Ratio	55.47[a]	37.64[a]	52.96[a]	97.76[a]
L.H.S. Mean	48.03	24.26	13.12	6.16
S.E.	9.06	5.89	5.03	1.33
Dur-Wat	2.04	1.72	0.37	1.91
NOB	18	18	18	18

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level.

Note: these results are presented with the TIME variable equal to the year in question.

TABLE B.12

Fertilizer Application Rate Model Results
Saskatchewan
(pounds per acre)

	WHEAT		OATS		BARLEY	
	Stubble	Fallow	Stubble	Fallow	Stubble	Fallow
Intercept	-72724.00 (445.5)[a]	-21033.50 (240.0)[a]	-41806.8 (280.9)[a]	-773.20 (211.11)[a]	-2883.7 (410.7)[a]	-974.12 (279.8)[a]
PGRAIN/PIF	-0.03 (2.15)[ns]	0.85 (1.16)[ns]	1.52 (3.98)[ns]	1.06 (2.99)[ns]	0.25 (3.02)[ns]	1.35 (2.05)[ns]
TIME	1.39 (0.23)[a]	0.53 (0.12)[a]	0.92 (0.14)[a]	0.40 (0.11)[a]	1.47 (0.21)[a]	0.50 (0.14)[a]
Adjusted R^2	0.68	0.52	0.71	0.42	0.74	0.41
F-Ratio	19.02[a]	10.03[a]	21.79[a]	7.21[a]	25.62[a]	6.93[a]
L.H.S. Mean	13.76	7.35	8.96	5.66	13.24	8.55
S.E.	4.96	2.67	3.11	2.33	4.53	3.09
Dur-Wat	0.60	0.72	0.77	0.75	0.64	0.73
NOB	18	18	18	18	18	18

TABLE B.12 (cont'd)

Fertilizer Application Rate Model Results
Saskatchewan
(pounds per acre)

	RAPESEED		FLAXSEED	
	Stubble	Fallow	Stubble	Fallow
Intercept	-4879.90 (744.1)[a]	-2712.60 (413.8)[a]	-1686.40 (271.8)[a]	-603.90 (83.9)[a]
PGRAIN/PIF	0.78 (2.58)[ns]	0.69 (1.44)[ns]	0.34 (0.69)[ns]	0.20 (0.21)[ns]
TIME	2.48 (0.38)[a]	1.38 (0.21)[a]	0.86 (0.14)[a]	0.31 (0.04)[a]
Adjusted R^2	0.80	0.81	0.70	0.77
F-Ratio	27.23[a]	27.86[a]	20.89[a]	29.02[a]
L.H.S. Mean	16.81	9.04	4.62	2.31
S.E.	5.18	2.88	2.98	0.92
Dur-Wat	1.16	1.81	0.41	0.83
NOB	18	18	18	18

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level.

TABLE B.13

Fertilizer Application Rate Model Results
Alberta
(pounds per acre)

	WHEAT		OATS		BARLEY	
	Stubble	Fallow	Stubble	Fallow	Stubble	Fallow
Intercept	-6925.50 (621.9)[a]	-1996.70 (336.5)[a]	-4638.5 (364.7)[a]	-1595.30 (311.9)[a]	-7624.0 (464.6)[a]	-1783.30 (378.5)[a]
PGRAIN/PIF	3.96 (3.00)[ns]	3.47 (1.62)[ns]	13.03 (5.17)[ns]	6.11 (4.42)[ns]	5.19 (3.41)[ns]	4.72 (2.78)[ns]
TIME	3.53 (0.32)[a]	1.02 (0.17)[a]	2.36 (0.19)[a]	0.82 (0.16)[a]	3.89 (0.24)[a]	0.91 (0.19)[a]
Adjusted R^2	0.88	0.71	0.91	0.63	0.94	0.61
F-Ratio	65.38[a]	21.49[a]	91.68[a]	15.66[a]	144.87[a]	14.48[a]
L.H.S. Mean	40.53	18.59	25.97	14.60	38.78	22.00
S.E.	6.92	3.75	4.03	3.45	5.13	4.18
Dur-Wat	0.69	0.86	1.09	0.79	1.13	1.10
NOB	18	18	18	18	18	18

TABLE B.13 (cont'd)

Fertilizer Application Rate Model Results
Alberta
(pounds per acre)

	RAPESEED		FLAXSEED	
	Stubble	Fallow	Stubble	Fallow
Intercept	-13308.00 (1214.4)[a]	-6560.70 (831.5)[a]	-4958.70 (526.8)[a]	-1642.40 (128.3)[a]
PGRAIN/PIF	3.18 (4.22)[ns]	1.84 (2.89)[ns]	2.41 (1.34)[ns]	0.78 (0.33)[ns]
TIME	6.77 (0.62)[a]	3.34 (0.42)[a]	2.52 (0.27)[a]	0.84 (0.07)[a]
Adjusted R^2	0.92	0.86	0.86	0.92
F-Ratio	77.66[a]	40.69[a]	51.51[a]	95.19[a]
L.H.S. Mean	51.67	24.51	14.94	6.64
S.E.	8.45	5.79	5.78	1.41
Dur-Wat	1.49	1.42	0.37	1.19
NOB	18	18	18	18

a significant at the 1% level
b significant at the 5% level
c significant at the 10% level
ns not significant at the 10% level.