MEASURING THE CAPITALIZATION OF INCOME TRANSFER PROGRAMS INTO AGRICULTURAL ASSET VALUES

Final Report

Submitted to
Agricultural Canada, Policy Branch

Prepared by:

Dr. Calum G. Turvey (Principal Investigator)
Dr. Karl Meilke (Co-Investigator)
Dr. Alfons Weersink (Co-Investigator)
Dr. Stephen Clark (Co-Investigator)
Dr. Kurt Klein (Co-Investigator)
and
Dr. Rakhal Sarker (Research Associate)

Correspondence to
Dr. Calum G. Turvey
Department of Agricultural Economics and Business
University of Guelph
Guelph, Ontario
N1G 2W1

Phone: (519) 824-4120 ext. 2765
FAX: (519) 767-1510

March 30, 1995

EXECUTIVE SUMMARY

The transfer efficiency assessment of a support program is usually measured by its effectiveness in distributing benefits within the agri-food sector. A framework for assessing transfer efficiency was recently presented in a Deloitte & Touche study entitled *How Governments Affect Agriculture*. This framework outlined the flow of program benefits among administration costs, consumers, processors, input suppliers, holders of farm assets, and ultimately net gains to farmers. The entire agri-food sector can be affected by government intervention due to market responses. The increase in the value of assets used in agricultural production are mentioned in the Deloitte & Touche framework as one of the important outflows from government support payments. However, such capital gains are not explicitly modelled despite the fact that it can have significant impact on the agri-food sector. The current report was commissioned by Agriculture Canada to measure the extent to which income transfer programs of the government are capitalized into agricultural asset values by Canadian producers.

This report first reviews studies which examine movements in aggregate farmland prices. Most studies have focused on the demand forces which determine equilibrium prices. The basic premise has been that an income earning asset should follow the present value model in which net returns to the asset is the only variable that needs to be considered. However, the assumptions of the capitalization model have recently been questioned and other variables have been proposed to explain changes in farmland prices. These include explosive expectations, capital gains considerations, credit market constraints, non farmland returns to land, non farmland investment opportunities, and macroeconomic considerations. Thus, a definitive model of farmland prices has not yet been determined.

The alternative approaches to modelling changes in farmland prices have always included a variable for net real returns. Generally, this variable incorporates the support benefits associated with government programs. However, only a few studies have empirically examined the effect of these government programs on land prices. The empirical evidence is summarized below. A U.K. study estimated that a one percent increase in support prices would reduce the level of employment of hired labour by around one percent. Investment increased net farm income by around 9% but most of the benefits were capitalized into land values which rose by about 10%. Veeman, Dong and Veeman (1993) conclude that the abolition of direct government transfer payments in Canada would reduce total farm cash receipts by 13%. This will lead to a drop in land price by 5% and 18.5% in the short run and in the long run respectively. A study focusing on wheat producing regions in France, U.S., and Canada estimated that a 1% increase in Producers Subsidy Equivalents would correspond to an increase in land prices of 0.38%. The incomplete capitalization of wheat subsidies into land values likely reflects uncertainty regarding the future path of government protection of agricultural markets as well as support not tied to land itself. A U.S. study also found government payments to have little effect on annual changes in U.S. land prices. Because of their stabilizing effects, this study found government payments in the U.S. account for only a small portion of the fluctuations in land values although they account for approximately 15 to 25% of the capitalized value of land. Thus, the limited empirical evidence provides no consensus on the extent to which government support is capitalized into land values

In this report, a theoretical model is developed which extends the basic present value model by permitting the discount rate at which annual returns are capitalized into land values to be a function of the type of returns; market returns vs. government support payments. Land values, thus, depend on lagged land prices and expected net incomes from production and government sources. This specification allows one to examine the extent to which the different sources of returns are capitalized into asset values.

The capitalization of program benefits into land and other farm assets depends on the type of program and the level and consistency of support under that program. The characteristics of the agricultural sector being targeted by the program is also an important factor. In general, the more variable are cash flows from a farm program, the slower will be the rate of capitalization of program benefits into land and other farm assets. If farm programs are structured in such a way that they provide a reasonable perception of permanence, then direct income transfers through government programs will have a significant affect on farm asset values. Benefits from rich and commodity specific programs such as GRIP are most likely to get capitalized into land values at a faster rate than those from provincial price stabilization or crop insurance. Similarly, dairy subsidies are more likely to get capitalized into quota values than into land values. Since the benefits under various *ad hoc* programs such disaster relief, floods, drought etc. are temporary and do not create any expectation for consistency of these benefits, these benefits are unlikely to get capitalized into land or any other farm assets.

The land capitalization model with time-varying discount rates developed in this report was applied to analyze farmland price changes in Ontario and Saskatchewan. Data on land prices, net farm incomes from production and direct government subsidies per acre were used in the empirical analysis. Preliminary data analysis indicated the presence of unit root nonstationarity in each of the data series. Since traditional regression analysis is not valid when nonstationarity characterize the data, Canonical Cointegrating Regression (CCR) developed by Park (1992) was used to estimate and test the relationships among the variables. The results indicate that there is a stable long-run relationship among the three variables both in Ontario and Saskatchewan. The estimated long-run relationships were used to calculate the long-run discount rates and long-run elasticities of land price with respect to net farm income and subsidies. The estimated long-run discount rate is 8.7% for Ontario. While the elasticity of land price to net income and subsidy are both inelastic, the income elasticity of land price is higher than the subsidy elasticity of land price in Ontario. For Saskatchewan, the long-run discount rate is 13.5% and the income elasticity of land price is 1.67. However, the elasticity of subsidy to land price is only 0.86%. The results indicate that farmers view subsidy income different from net farm income in making land-capitalization decisions in Ontario but not in Saskatchewan. Finally, government subsidies have significant positive impact on land prices both in the short-run and long-run.

In addition to the long-run results generated from cointegration analysis, estimates of structural parameters are also obtained using regression analysis with a time-varying discount rate. The estimates of average long-run discount rates and income as well as subsidy elasticities of land prices obtained from the structural model are comparable to those obtained from cointegration analysis. These results along with those from the cointegration analysis support the contention that government program benefits are capitalized into land values. The rate of capitalization, however, varies across provincial boundaries. In general, land prices in Ontario are more responsive to government programs than those in Saskatchewan. This difference could be attributed to differences in risk postures between the two provinces.

The effects of government programs on quota values were also investigated. Different aspects of supply management quotas are examined and their effects on new entry, industry costs etc. are discussed. The capitalization of program benefits on quota values are explored first analytically. Finally, to examine the empirical results of income capitalization on quota values, the asset capitalization model used for studying land capitalization was applied to milk quota values (for unused MSQ quotas) for Ontario milk producers. The estimated long-run discount rate for milk quotas in Ontario is 8.10% which is close to the long-run discount rate for land prices in Ontario. However, the quota values are highly income elastic compared to land prices.

An attempt is made in the final section of the report to show how the land capitalization model can be linked to the Deloitte & Touche framework. The welfare analysis of land capitalization and quota capitalization have also been performed.

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1. INTRODUCTION

1.1. Background:

The transfer efficiency assessment of a support program is usually measured by its effectiveness in distributing benefits within the agri-food sector. While most farm programs are directed at farmers, in terms of income support, not all of this money remains with the farmers for consumption or reinvestment. A considerable benefit is transferred from the farmer to the suppliers of inputs, processors, distributors in the product market, and final consumers. Other responses may include increased production of supported commodities relative to non-supported commodities, or increased investment and capitalization of asset values due to demand factors. These adjustments result in an economy wide adjustment that may or may not have been intended by the policy initiative.

Identifying farm-level and industry wide responses to agricultural support programs is important as these responses may affect the efficiency of income transfers to the agricultural sector. In this respect, it is important to know, understand and measure how gross benefits are shared among the agri-food market participants and the level of net gain to farmers. If farm programs are not providing the intended level of income support to the desired beneficiaries (i.e., the primary producers), then the efficiencies of the programs are called into question.

A framework for assessing transfer efficiency was recently presented in Deloitte & Touche study entitled, **How Governments Affect Agriculture**. This framework outlines the flow of program benefits among administration costs, consumers, processors, input suppliers, holders of farm assets, and ultimately net gains to farmers. The complete agri-food sector can be affected by government intervention due to market response to the intervention.

The increase in the value of assets used in agricultural production are mentioned in the Deloitte & Touche framework as one of the outflows from government support payments. However, such capital gains are not explicitly modelled despite the fact they can have adverse farm-level effects (i.e., restrict new entry). Anecdotal evidence suggests that the introduction of Gross Revenue Insurance Program (GRIP) raised land prices in southwestern Ontario.

Direct payments to farmers under various government programs are primarily designed to augment net farm income. If these programs are stable and rich, then a larger portion of the program benefits is used by the farmer to acquire new resources, particularly land. Given the inelastic supply of land, additional farm income from government subsidies can bid up the price of land. This phenomenon is known as the capitalization of farm program benefits into land values. Note that benefits from various farm programs can get capitalized into other farm assets as well. Under these circumstances, program benefits cannot have desirable long-term effects on net income to farmers. On the contrary, they induce higher demand for farm assets and increase the cost structure of the industry. While increased asset value improves the equity position of current farmers, it severely limits the profitability of beginning farmers. Moreover, if the sector is producing for international export destinations, land capitalization can seriously affect the competitiveness of Canadian farmers in the global market. Asset capitalization can also have negative distributional consequences for the domestic economy. Because of all these reasons, it is important to capture the capitalization effects of program benefits while measuring the transfer efficiency of farm level programs.

This report was commissioned by Agriculture and Agri-Food Canada to measure the extent to which income transfer programs of the government are capitalized into agricultural asset values by Canadian producers.

1.2. Objectives:

Measuring the capitalization of income transfer programs into Canadian agricultural asset values is accomplished through the achievement of the following four objectives:

1. Provide an analytical approach to determine whether and to what extent the various forms of government transfers to the Canadian agricultural sector are capitalized into the value of farm assets.

2. Extend the theoretical framework developed in the *Deloitte & Touche (1993)* report regarding transfer efficiency of government assistance programs to include the potential impacts of the capitalization of these transfers.

3. Provide the conditions or factors concerning program design and sectoral characteristics that may result in the capitalization of income transfers into farm assets.

4. Assess the implications regarding program capitalization for the present programs offered to the supply managed, grains and oilseed, and red meat sectors.

1.3. Organization of the Report:

Section two of this report provides an extensive review of existing land valuation models. The following section presents an approach that differentiates the capitalization effects on land values due to market returns and government programs. This approach also incorporates time-varying discount rates in land capitalization analysis. Section four describes the characteristics of major farm programs and discusses which program benefits are more likely to get capitalized into land and other farm assets. This section also provides a welfare analysis of asset capitalization. Section five briefly reviews the relevant estimation issues and provides an overview of the estimation methods. It also provides a brief introduction to cointegration analysis. Section six describes the data and some of their general characteristics. The empirical results from cointegration analysis pertaining to the capitalization effect of government programs on land values in Ontario and Saskatchewan and the capitalization of economic rent on quota values are presented in section seven. This section also presents results from the structural model. The time-varying discount rates and land price elasticities are calculated and compared for Ontario and Saskatchewan. The predictive performance of the structural model is also evaluated in this section. Section eight concentrates on supply management and quota values. Capitalization of quota values and other related issues are discussed and a welfare analysis of quota capitalization is presented in this section. Section nine shows how the asset capitalization model presented in this report can be linked to the Deloitte & Touche model. The final section summarizes the key results and concludes the report.

2. REVIEW OF EXISTING LITERATURE ON LAND CAPITALIZATION:

There has been a significant interest in how economic rents and government subsidies are capitalized into land value and other capital assets. The purpose of this section is to review the asset capitalization literature in such a way as to aid in the development of an appropriate land capitalization model.

Boom and bust cycles in asset values appear to be an inherent characteristic of the agricultural sector. The explosive appreciation of these values in the 1970s followed by the rapid depreciation in the 1980s is the most recent example of such a price swing. However, Melichar (1984) notes that there have been several other similar price cycles during the last two hundred years. The variation in asset values has led researchers to examine the economic forces determining these values and to assess whether the asset is overpriced or underpriced. While the fundamental economic questions regarding asset values have not changed, the approaches to addressing them have. This review provides a chronological account of the developments and focus of studies examining farm asset values. Five major approaches can be identified as illustrated in Figure 1. The emphasis within each category is on studies assessing land values since land represents the major income producing asset in agriculture.[1]

2.1. Ricardian Approach:

Two major assumptions were the underpinning of the earliest studies on asset values according to Doll, Widdows and Velde (1983). The first is that farm income per acre is the appropriate variable against which to measure land value. The second assumption is that the present value of the asset is equal to its annual earnings divided by a discount rate. This capitalization formula is derived under the assumption that the value of an income producing asset is the capitalized value of the current and future stream of earnings from owning the asset;

$$L_t = \sum_{i=0}^{\infty} \frac{E(R_{t+i})}{(1+r_{t+1}).(1+r_{t+2}).......(1+r_{t+i})} \tag{2.1}$$

where L_t is the equilibrium asset price at the beginning of time period t, R_t is the residual real return generated from owning the asset measured at the end of time period t, r_t is the real discount rate for year t, and E is the expectation on returns conditional on information in period t. The maximum bid price that a buyer would offer and the minimum asking price that a seller would accept will converge to the unique equilibrium price in equation (1) assuming symmetry in the market between the opportunity cost for a seller and the returns for a buyer (Robison, Lins and VenKataraman, 1985). If it is assumed that the discount rate is constant, the agents are risk

[1] The review of quota value literature is given in section 8 of this report.

Figure 1:

neutral, and differential tax treatments of capital gains and rental income are ignored (Hamilton and Whiteman, 1985), then the asset valuation model given by equation (2.1) becomes;

$$(2.2) \qquad L_t = \frac{1}{(1+r)} \sum_{i=0}^{\infty} \frac{E_t(R_{t+i})}{(1+r)^i}$$

Assuming that the residual return, R*, is constant in each period, equation (2.2) simplifies further to the traditional capitalization formula;

$$(2.3) \qquad L_t = \frac{R^*}{r}$$

The inclusion of ordinary income taxes will not change the capitalization formula in the absence of growth (Baker, Ketchabaw, and Turvey, 1991). The capitalization formula in Equation (2.3) formed the foundation for the early studies on asset values with residual returns measured by net farm income (see Klinefelter 1973 and Castle and Hoch 1982). However, the divergence of asset values from farm income trends forced researchers to examine the validity of the capitalization formula and assumptions used in its derivation. A number of alternative explanations were proposed including productivity increases, government programs, and urban pressures. In the 1960s, these variables were introduced using estimated supply and demand relationships for the asset.

2.2. Supply and Demand Models:

In a simplified conceptual framework of the market for agricultural land, a potential purchaser of a tract of land is assumed to have an offer price which represents the maximum that the individual would be prepared to pay. Similarly, the land owner has a reservation price which is the minimum that he is willing to accept for the land. A transaction will occur if the purchaser's offer price exceeds the land owner's reservation price. If we assume a market of identical units, and order potential purchasers in descending order of offer prices and potential sellers in ascending order of reservation prices, demand and supply curves respectively for the land market can be obtained as illustrated in Figure 2. Note that the supply curve contains a vertical section where all agricultural land is available for sale. The intersection represents the equilibrium land price and the number of units sold. The factors which then influence the equilibrium price for farm land are the factors which influence the offer and reservation prices of present farmers, potential farmers, and land owners.

There were several studies of farmland price determination in the 1960's using a simultaneous equation framework based on the above conceptual model. Two equation models

Figure 2

explaining U.S. farmland values and farmland transfers were developed by Herdt and Cochrane (1966) and Reynolds and Timmons (1969). In the Herdt and Cochrane model supply of farmland is assumed to be a function of its value, the rate of return on nonfarm investment, the unemployment rate, and the amount of land in farms. Demand is a function of land value, nonfarm investment return rate, a productivity index, the ratio of farm prices received to prices paid index, and the wholesale price index. The dependent variable for both equations is the number of farm transfers. Herdt and Cochrane concluded that technological progress and government supported output prices have influenced farmland prices. The Reynolds and Timmons model had supply as measured by the number of transfers a function of the debt to equity ratio, labour use in farming, a ratio of farm to nonfarm earnings, change in average farm size, and expected capital gains on farmland. Demand as measured by price was a function of the number of transfers, government payments for land diversion, conservation payments, change in average farm size, expected capital gains, rate of return on nonfarm investment, and expected net farm income. Reynolds and Timmons found expected capital gains, government payments for land diversion, conservation payments, farm enlargement were important variables in explaining land prices. Tweeten and Martin (1966) used a five equation model to explain U.S. farmland values, transfers, farmed and cropped area, and farm numbers. Land price was a function of the farmland area, the number of transfers, the number of farms, expected farm income, rate of return on nonfarm investment, and lagged price. They found the major determinants of changes in farmland prices to be pressures for farm expansion and capitalized benefits from government programs tied to land.

Although the above supply and demand models explained farmland price variations reasonably well within the period for which they were estimated, Pope et al (1979) re-estimated them using more recent data and the models were found to be ineffective in explaining the divergence between farm income and land values of the 1970s. Much of the problem with the supply and demand approach is that a classic supply function for farmland does not exist due to the inelastic nature of farmland quantity (Burt, 1986). This argument was supported empirically by Pope et al. (1979) who found that single equation model developed by Klinefelter(1973) had the best out-of-sample prediction performance of the models tested. The land price equation of Klinefelter had net farm income, average farm size, number of transfers, expected capital gains, and GNP deflator as explanatory variables. As a result of the theoretical and empirical questions surrounding the simultaneous modelling of the farmland market, most subsequent studies of farmland price movements have focused on the role of demand forces. These forces involve the returns which can be generated from the asset. Consequently, the emphasis returned back to the PVM. An exception is the recent study by Lopez, Shah, and Altobello (1994) who develop a supply-demand model of the amount of land in agriculture to determine the optimal allocation of land among competing uses.

2.3. Extension of Present Value Model:

The problems with the supply and demand models of the land market combined with a study on the causes of asset appreciation by Melichar (1979), led to a shifting of the emphasis of land value studies back to the capitalization formula. Melichar pointed out the inappropriateness of net farm income as a measure of the return to land. In general, net farm income represents the returns to farm labour, management and land; only the residual net income after subtracting the returns to farm labour and management, is the relevant return to land. He also noted that current returns to farm assets grew rapidly over a 25 year period beginning in the mid 1950s which resulted in the large annual real capital gains and a low rate of current return to farm assets. On the basis of this historical experience, Melichar modified the capitalization formula to account for growth in earnings.

$$(2.4) \qquad L = \frac{1+g}{1+r}R + \frac{1+g}{1+r}L = \frac{1+g}{r-g}R$$

where g is the annual growth rate of the current return R.[2] Thus, land values can change with changes in the returns and the discount rate plus the growth rate in returns which was the driving force in increasing land values during the 1970s. If the growth rate is greater than zero, the equilibrium land price increases each year even if the growth rate and discount rate remain unchanged from year to year. Castle and Hoch (1982) model farmland price as an identity made up of the capitalized value of net rent from agriculture obtained on owned land and by a capital gains component which is decomposed into a part specific to agriculture and another associated with general price level changes. However, Melichar's results indicate that capital gains themselves can result from a growing stream of net rents. The present value formulation given by equation (2.3) can be derived by solving the following equation recursively;

$$(2.5) \qquad L_t = \frac{E(L_{t+1}+R_t)}{(1+r)}$$

which shows Melichar's point that capital gains can be explained in theory as the capitalization of expected future rents (Falk, 1991).

Following Melichar's lead, the next series of papers on land values attempted to relax some of the assumptions in the present value model. Alston (1986) assumed that rental income grows exponentially at a constant nominal rate but differs from the approach of Melichar by distinguishing between the tax rate on income (Ty) versus capital gains (Tc). The distinction between the tax rates, results in modifying the capitalization formula given in equation (2.4) as:

$$(2.6) \qquad L_t = \frac{(1-T_y)R_t}{[r-(1-T_c)g]}$$

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2 Interested readers are referred to Doll and Widdows (1981) for details on equation (2.4).

Alston then decomposes the discount rate into a risk premium for land (c) and the nominal market interest rate (i) which earns interest income that is taxable (r = c + (1-Ty)i). Substituting this definition of the discount rate into equation (2.6) results in an asset price which is still equal to current expected rental income divided by a discount rate but the discount rate is now adjusted for income growth (capital gains) and taxes.

Alston empirically estimated a version of equation (2.6) which allowed him to examine two competing hypotheses proposed by Melichar and Feldstein. Melichar's model, as described above, assumes the discount rate to be constant so that land prices grow at the same rate as income to land. In his model of portfolio equilibrium in which farmland is an investment to be considered relative to other assets, Feldstein (1980) suggested that increases in expected inflation cause a decrease in the discount factor thereby leading to an increase in real land prices. The result is due to the preferential treatment given to capital gains income. However, in his empirical analysis, Alston concluded that most of the growth in real land prices for several countries including Canada is explained by real growth in net rental income and that inflation has had only a small negative effect.

The present value model also formed the basis of a study by Burt (1986). Burt noted that there are two sources of dynamic behaviour in the basic model given in equation (2.2). The first is the expectations with regard to rents and the second is the adjustment mechanism for the asset price which will not adjust instantaneously to changes in net returns. Burt approximated the composite effects of both expectations and the dynamic adjustment process with a multiplicative distributed lag specification on net rents which encompasses a family of alternative dynamic structures. In addition, Burt assumes a constant real discount rate since investors in land are concerned with the long run equilibrium rate and do not account for yearly movements in the real rate. With these two assumptions, the dynamic regression of equation (2.2) expressed in logs is,

$$(2.7) \qquad \log L_t = \log \alpha + \sum_{i=0}^{\infty} \beta_i \log R_{t-i} + \log u_t$$

where β is the reciprocal of the constant real capitalization rate (r) and u is a random disturbance term which is assumed to follow an ARMA process with expectation zero. Burt assumes a second-order rational lag approximation to the general multiplicative lag structure in equation (2.7) which results in the following equation which he estimates for Illinois land prices:

$$(2.8) \qquad \log L_t = \delta_a + \delta_0 \log R_t + \delta_1 \log R_{t-1} + \lambda_1(\log L_{t-1} - \log u_{t-1}) + \lambda_2(\log L_{t-2} - \mathrm{lo}$$

The difference in the specification of the two studies is that Burt uses an explicit but robust lag specification while Alston uses a tightly prameterized model of thirteen lags on past land prices and no lags on net real returns. However, Alston does allow more flexibility on the capitalization rate which is assumed to be constant by Burt.

The Burt approach was followed by Weisensel, Schoney and van Kooten (1988) and Veeman, Dong and Veeman (1993) in their studies of the determinants of Canadian farmland prices. Featherstone and Baker (1988) also start from the capitalization formula with dynamics entering into the market through the expectations of returns to land and the adjustment mechanism for land prices. However, they assume an ad hoc adaptive process in which cash rent is a weighted average of current and past residual returns from land. Past and historical cash rents then determine land value. The result is a recursive system in which the length of the lags are determined empirically.

Burt concludes that the annual percentage change in Illinois land prices consists of two components: (i) a systematic component and (ii) an error component. The percentage change in land price in the previous year represents the systematic component while the difference between the equilibrium land price based on current expected rent and the most recently observed land price represents the error (actually, the expectational error) component. The systematic component dominates the error component. Burt argues that while the systematic component is an implicit function of lagged rents, it is exogenous in the model and should not be interpreted as a measure of capital gains as has been proposed by some in the literature (e.g., Castle and Hoch, 1982). Burt also notes that land prices are driven mostly by changes in net rents and not by the speculative forces.

Burt also tested the theoretical model of Shalit and Schmitz (1982) in which the demand for farmland is derived from a life-cycle utility maximization problem faced by a hypothetical farmer. The assumption of credit rationing forces the accumulated debt level to be a major determinant of farmland value along with income and several factors affecting consumption including the interest rate (Burt, 1986). Burt included debt per acre as an explanatory variable in one of his equations and found it to be statistically insignificant and very small in magnitude. Weisensel, Schnoney and van Kooten (1988) also refute the Shalit and Schmitz hypothesis and suggest that increased land values may be a determinant of the increased credit use rather than the reverse. Just and Miranowski (1993) also found debt to have little influence on land values since debt levels are a relatively small value of land holdings, implying that credit is not a major constraint to land purchases.

2.4. Time Series Analysis:

The empirical implication of the previous studies that net real returns is the major variable explaining land values was brought into question in a series of papers beginning with Featherstone and Baker (1987). In comparison to the analysis of Burt (1986), their study covered a much longer time frame and used a different statistical methodology, vector autoregression (VAR), in which equations for asset values, returns to assets, and interest rates were estimated. Lags of each variable were used as regressors in each equation. By specifying lagged asset values in addition to the expectations processes for rents and interest rates as explanatory variables in the reduced form equation for asset values, Featherstone and Baker (1987) were able to test for the presence of an asset price bubble. Such a bubble may arise if market participants focus on irrelevant variables such as past capital gains rather than movements in returns and real interest rates. Their results show that speculative forces play a major role in determining farmland prices in the U.S.. A one-time transitory shock in real asset value, real returns to assets or the real interest rate all lead to a change in asset value which lasts for six years when the effect begins to die out. The implication is that the land market has a propensity for asset price bubbles and that the large and random price responses are inconsistent with a present value formulation.

The assumption that net real returns is the major determinant of asset value as proposed by the present value formulation has been tested recently with new statistical procedures involving cointegration tests. Much of the previous literature in support of the present value method including Alston (1986), Burt (1986) and Weisensel, Schoney and van Kooten (1988) and Veeman, Dong and Veeman (1993) used traditional time series regression analysis. However, if the data are characterized by nonstationarity, such methods may suffer from the spurious regression problem originally studied by Granger and Newbold (1974). The concept of cointegration in the sense of Engle and Granger (1987) between land price and a set of explanatory variables becomes an important empirical consideration when unit roots characterize the data.

Campbell and Shiller (1987) rigorously demonstrated the relationship between unit root non-stationarity and cointegration within the context of present value models such as the simple capitalization formula of land valuation given by equation (2.2). Campbell and Shiller show that if the present value model is correct, then (i) net rents and land prices should have the same time series properties; and (ii) past values of the spread between land prices and rents add useful information in forecasting future changes in rents given past changes in net rents. Further elaboration on the statistical procedures is provided later. Using these procedures for Iowa, Falk (1991) found that although farmland price and rent movements are highly correlated, price movements are more volatile than rent movements. Falk rejects the present value model on the basis of the second set of restrictions suggested by the model as formulated above by Campbell and Shiller. Using the same procedures but with the data employed by Featherstone and Baker (1987), Clark, Fulton and Scott (1993) also found that the simple asset pricing model did not hold. However, unlike Falk (1991), they found the time series representation of rents and land prices to be inconsistent as did Baffes and Chambers (1989). Tegene and Kulcher (1993) also rejected the present value method as a means of approximating U.S. farmland price movements using a slightly different time series method, which had previously been employed to study stock price movements. Possible reasons for rejection of the present value model, include (i) the presence of rational speculative bubbles in which prices deviate from their fundamentals associated with rents and interest rates as suggested by Featherstone and Baker (1987), (ii) time varying discount rates, and (iii) satisficing behaviour where farmers get both monetary (rents) and nonmonetary forms (security or pride of ownership) of returns to farmland. In contrast to these studies, Clark, Klein and Thompson (1993) found some support for the capitalization formula model using Saskatchewan data.

Ahrendsen and Khoju (1994) relax the assumption of a constant discount rate in their cointegration analysis of rents and farmland prices. After estimating the following equation;

$$\ln L_t = \$_0 + \$_1 \ln R_t + \$_2 \ln R_{t-1} + \$_3 \ln L_{t-1} + \$_4 \ln L_{t-2} + w_t \tag{2.9}$$

the null hypothesis of a constant discount rate is rejected since the intercept term is significantly different from zero and the sum of the other regression coefficients does not equal 1. They then use the vector autoregression framework of Johansen (1991) in which farmland prices, rents and the interest rates are affected by the lags of all three variables in the system to obtain one cointegrating vector of those variables. On the basis of the estimated coefficients in this vector, they find that a one percent increase in cash rent increases farmland price by 2.82 percent while a one percent increase in farm mortgage rates decrease farmland price by 0.21 percent.

2.5. The Structural Model:

Just and Miranowski (1993) represents a departure from the recent free form time series econometric investigations of land prices as mentioned above. They develop a comprehensive structural model for analyzing land prices. An open loop stochastic optimal control approach with a single period planning horizon is used to determine the relative importance of various factors influencing farmland prices. In this model, wealth accumulation is assumed to be a driving force in land markets in addition to the discounted value of returns. An expected utility function separable in consumption and wealth is maximized subject to equations of motion for debt, savings, land holdings and land value through the choice of variable inputs and land purchases. From the first order conditions an aggregate land price model is developed. This model is then solved for a land price expression. While this is a more general representation of land price formation than in any previous model, it is a complicated function of inflation, taxes, credit market imperfections, transaction costs, risk aversion and the discount rate. In absence of taxes, credit market imperfections, risk etc. the model reduces to a standard discounting equation. Note that there is only one free parameter in their empirical model.

The estimated model is used to decompose the predicted price changes according to their effects represented by the various terms in the aggregate land price equation. Government payments are a minor factor in explaining year to year changes in land prices (explained further below). Land price expectations are the most important explanatory variable. However, the change in land price expectations is explained by changes in previous prices and thus, indirectly by previous changes in other variables. The most important variables are inflation and the real return on alternative uses of capital. These macroeconomic effects caused substantial appreciation in 1973 and 1979 and substantial depreciation in 1982. The large shock of 1973 continued as indirect effects worked their way through land price expectations. Real returns were in actual decline following 1973, so that only a lag distribution with relatively more weight on longer lags than shorter lags can explain the rising land prices of the mid 1970s on the basis of changes in returns to farming (e.g. Alston (1986) and Burt (1986)). The results of Just and Miranowski (1993) suggest that the tendency of land prices to overreact to changes in rents (Featherstone and Baker (1978); Falk (1991)) is explained by inflation and opportunity cost.

In summary, studies examining movements in aggregate farmland prices have focused on the demand forces determining equilibrium price since the 1970's. The basic premise has been that an income earning asset should follow the present value model in which net returns to the asset is the only variable that need be considered. However, the assumptions of the capitalization model have been recently questioned and other variables have been proposed to explain changes in farmland prices in addition to changes in returns to farming. These include explosive expectations, capital gains considerations, credit market constraints, non farmland returns to land, non farmland investment opportunities, and macroeconomic considerations. Thus, a definitive model of farmland price has not yet been determined. Neither has a definitive model on the effects of government programs on land values as discussed in the next section. This paper presents a model that separates out the effects of returns from farm production and government programs while allowing for a time varying discount rate which has been a limitation of previous present value models.

2.6. Empirical Evidence on the Influence of Government Programs on Farmland Values:

The alternative approaches to modelling changes in farmland prices have always included a variable for net real returns. Generally, this variable incorporates benefits associated with government programs. However, only a few studies have empirically examined the effect of these government programs on land prices. The empirical evidence is summarized below.

Traill (1982) developed a 31 equation model of the U.K. agricultural sector. Demand and supply equations are specified for two inputs, labour and capital. The equilibrium capital and labour quantities and prices determine net farm income which subsequently determines the price of land along with the interest rate, and the amount of land sold. In the simulation model only agricultural support price level is changed to determine policy impacts on the endogenous variables in the model. The results indicate that for one percent increase in support prices the level of employment of hired labour would be reduced by about one percent but investment would be increased by about 2 percent. The increase in capital intensity reduced the demand for hired labour and consequently reduced agricultural earnings. Net farm income rose by around 9% but most of the benefits of such increases were capitalized into land values which rose by about 10 % although short term prices were quite unstable. The high rate of capitalization is perhaps related to the underlying structure of the model.

Featherstone and Baker (1988) estimated a recursive econometric model of cash rents and land values which was described earlier in section 2.1. Probability distributions of crop prices were generated under alternative policy options which were then used to determine the distribution of residual returns to land. These returns were then used in the econometric model to estimate cash rents which in turn determined land values. They found that a move to a more free market scenario from the 1985 farm program would reduce land prices by about 13 percent in five years.

Veeman, Dong and Veeman (1993) used a single equation model to describe land prices in four Canadian provinces using a distributed lag structure on real earnings similar to Burt (1986). The short run farmland price elasticity with respect to real farm cash receipts ranged from .26 to .47 while the long run elasticity estimates were generally three times larger than the short run effects. The estimates of the long run elasticity of land prices were consistent with a relatively inelastic supply of farmland. This feature suggests that changes in earnings that are assessed to be permanent in nature are likely to lead to more than proportional increases of land prices. Using the land value elasticities and the share of transfer payments in total cash receipts over the period 1986 to 1990, the impacts of a once-and-for-all removal of direct government transfer payments on land values were calculated. For Canada, the abolition of direct government transfer payments would reduce total farm cash receipts by 13% and consequently lead to a land price drop of 5% in the short-run and 18.5% in the long run. They concluded that government transfer payments have had a major impact in maintaining current levels of farmland values in Canada.

Clark, Klein and Thompson (1993) followed Campbell and Shiller (1987) to study the land capitalization effects of market generated net farm returns and farm subsidies. They used Johansen's maximum likelihood cointegration procedure along with Park's canonical cointegrating regression and Hansen's fully modified estimator to study the long-run relationships among these variables. They used the error correction model implied by the long-run model to examine the short-run effects of net farm income and government subsidies on land values. Using annual data for the period 1950-1987 for the province of Saskatchewan, they found that market generated returns alone cannot explain the secular growth in land values. However, when government subsidies were added to market returns (which is equal to total return), the new series could explain part of the variation in land values. Also, a long-run economic relationship was found between land prices and total returns. These results suggest that the short-term subsidies given under various government programs do get capitalized into land values.

Goodwin and Ortalo-Magne (1992) specified an empirical model that relates expected land values to expected levels of government support, expected yield and expected producer prices (net of direct govt. support). They used a generalized method of moments (GMM) estimator which allowed them to dynamically simulate future paths of land prices under alternative policies. Using pooled annual observations for the period 1979-89 for six wheat producing regions, Centre and Picardie in France, Kansas and North Dakota in the U.S., and Manitoba and Saskatchewan in Canada, they found that yield and output price elasticities of land price were slightly greater than one. In particular, with constant real costs of production, a 1% increase in producer price could lead to a 1.19% increase in land prices. Similarly, a 1% increase in yields would raise land values by 1.14%, 1.03% and 1.08% in the U.S., Canada and France respectively. The direct support to farmers was measured by the Producer Subsidy Equivalents (PSEs)[3] in this study. If government subsidies (i.e., PSEs) were to be permanent then a 1% increase in PSEs would increase land price by 0.38%. This suggests a significant degree of discounting on the part of land market agents. In particular, wheat subsidies did not appear to be fully capitalized into land values which likely reflects uncertainty regarding the future path of government protection of agricultural markets as well as support not tied to land itself. A 50% reduction of PSEs over the next decade would have a significant negative effect on land values in the EC but not in the U.S. and Canada. On the contrary, such a PSE reduction policy will have a small positive effect on land values in the US and Canada.

In contrast to the above studies, Just and Miranowski (1993) found government payments to have little effect in explaining annual changes in U.S. land prices. They found government payments seldom change significantly from year to year, and when they do, they only partially offset the change in market returns to farming. Because of their stabilizing tendency, government payments in the U.S. account for only a small part of the fluctuations in land values although they accounted for approximately 15 to 25% of the capitalized value of land.

[3] The Producer Subsidy Equivalents are an aggregate measure of support provided by government policies to agriculture. Included in the PSEs are market price support, direct government payments, input subsidies, general services and other indirect means of support. Obviously, a number of subsidies included in the PSEs do not go to farmers.

3. THE THEORETICAL MODEL

The theoretical models of land capitalization are a subset of the more general present value model of asset capitalization. As described in the previous section, a number of modifications have been made to the present value model over time. Assuming no differential tax rates, the current status of the present value approach can be summarized in the following equation:

$$L_t = \frac{R_t^*}{(i_t + B_t^* + c_t)} \tag{3.1}$$

Where L_t is current real land price at the beginning of the period t, R_t^* is the expected net rental income to land in period t, i is the nominal market discount rate, π^* is the expected inflation rate, and c is the risk premium for land.

In order to assess the effects of government programs on land values, two modifications are proposed to the existing capitalization formula given by equation (3.1). First, the economic rents are decomposed into those derived from production and those from government programs. Second, the discount rate is assumed to be time varying function of economic rents.

The first modification separates returns from the land base (R^*) into its two possible sources, production (P^*) and government (G^*) [so that, $R_t^* = P_t^* + G_t^*$]. Many studies have specified an economic rent that includes returns from both sources but no studies, with the exception of Goodwin and Ortalo-Magne (1992) and Just and Miranowski (1993), have isolated the two sources. The separation allows for the testing of the hypothesis that land prices respond differently to anticipated changes in the alternative sources of economic rents (i.e., H_0: $\partial L/\partial R^*.\ \partial R^*/\partial G = \partial L/\partial R^*.\partial R^*/\partial P$).

The second modification relates to the discount rate. In the majority of the previous studies focusing on the present valuation formulation and in all of the time series studies of land values, the discount rate is assumed to be constant. Burt claims such an assumption is appropriate since land purchasers and sellers are likely to use a long run equilibrium rate rather than actual annual rates. However, Fama and French in their study of stock prices explicitly recognize that time-varying discount rates are consistent with investors' preference for current versus future consumption and the stochastic evolution of their investment opportunities. If the discount rate in the present value model is the rate at which cash flows are reinvested, agricultural land as an investment will be profitable if reinvested cashflows at least pay off the land over time; that is, the investment must recover at least the cost of capital plus a risk premium. Even if it is assumed that the real cost of capital is constant the risk premium may not be and the latter may be lower with farm programs than without. Moreover, if farmers' perceptions of risk allow for revisions in its assessment then the discount rate will likely vary over time, in response to changes in expectations for G_t^* and P_t^* and the realized values of these variables. Falk (1991) suggests that the evidence of excess volatility in farm asset values may be explained by time-varying discount rates. Furthermore, farmland markets, unlike capital markets, are generally not liquid since change of ownership is infrequent, farmland assets are held for long periods of time, and most farmers purchase land only once or twice in a lifetime. Hence, it is not unreasonable to suspect that farmland investors in any one year will view long-run equilibrium values differently from those of the preceding years and will obtain these values using different, revised discount rates.

The discount rate in Equation (3.1) is altered to incorporate alternative risk perceptions by assuming that the risk premium is a linear function of the two different sources of economic rents (i.e., $c=\beta_g G^*+\beta_p P^*$). In addition, the equilibrium real rate of interest, α_0, is assumed to be constant over time. Thus, the difference between the nominal rate and the expected inflation rate is fixed at the real rate. Such an assumption is consistent with Fisher's classic theory of interest. While studies such as Feldstein (1980) have noted the influence of expected inflation on the discount rate and subsequently land prices, the empirical studies reviewed earlier found the effect to be negligible. Incorporating the modifications into Equation (3.1) results in the following capitalization formula:

$$(3.2) \qquad L_t = \frac{P_t^*+G_t^*}{\alpha_0+\beta_p P_t^*+\beta_g G_t^*}$$

The adjustment mechanism of land price to its equilibrium value are incorporated through the following two period lag structure which is consistent with the findings of a number of previous empirical studies such as Burt (1986) and Featherstone and Baker (1988). Setting aside the expectations on expected economic returns until actual estimation, an empirical representation of the present value model with a time varying discount rate that is a function of returns and an adjustment mechanism for land price can be represented as,

$$(3.3) \qquad L_t = \beta_1+\beta_2 L_{t-1}+\beta_3 L_{t-2}+(\beta_4 P_t^*+\beta_5 G_t^*)(P_t^*+G_t^*)$$

A number of hypotheses can be examined under the above land value equation (3.3). First, the effect of economic returns on land values could be assessed by determining if the estimated coefficients on rents are significantly different than zero. Failing to reject Ho: $\beta_4=\beta_5=0$ would imply that forces other than returns, such as speculative forces, are driving land values. Secondly, the validity of the assumption of a time varying discount rate can be tested. Such a test involves estimating an equation similar to Equation (3.3) except that the last term would be modified to $\beta_4'(P_t^*+G_t^*)$.

Assuming that Equation (3.3) is the correct specification after the above tests, the steady state land price will be as follows:

$$(3.4) \qquad L_t^* = \frac{P_t^* + G_t^*}{\dfrac{1-\beta_2-\beta_3}{\beta_4 P_t^* + \beta_5 G_t^*}}$$

The effects of an increase of economic returns from the two sources on steady state land values can then be determined through the following derivatives:

$$\frac{\partial L_t^*}{\partial P_t^*} = \frac{2\beta_4 P_t^* + (\beta_4+\beta_5)G_t^*}{(1-\beta_2-\beta_3)}; \quad \textit{Similarly,} \quad \frac{\partial L_t^*}{\partial G_t^*} = \frac{2\beta_5 G_t^* + (\beta_4+\beta_5)P_t^*}{(1-\beta_2-\beta_3)}$$

Changes in returns from production and government programs will thus have different effects on land values. An increase in farm returns will increase land values by a larger amount than an increase in government payments if $P > G\beta_5(1+\beta_4)/\beta_4(1+\beta_5)$. Similarly, the effects of changes in returns on the discount rate, r (the denominator of equation 3.4), can be determined. These derivatives are as follows:

$$\frac{\partial r}{\partial P_t^*} = \frac{-\beta_4(1-\beta_2-\beta_3)}{(\beta_4 P_t^* + \beta_5 G_t^*)^2}; \quad \textit{Similarly,} \quad \frac{\partial r}{\partial G_t^*} = \frac{-\beta_5(1-\beta_2-\beta_3)}{(\beta_4 P_t^* + \beta_5 G_t^*)^2}$$

Both derivatives are likely to be less than zero under reasonable parameter estimates. Thus, an increase in either production returns or government payments will decrease the discount rate and thereby increase land price. A dollar of income earned from farm production will be capitalized at a greater (smaller) rate than a dollar of expected government payment if β_4 is greater (smaller) than β_5. The specification of the above land capitalization model thus allows us to determine absolute as well as relative effects of farm income from alternative sources on land values.

4. PROGRAM CHARACTERISTICS AND ASSET CAPITALIZATION

The capitalization of income transfers into land and other asset values will be contingent upon 1) the level of support, 2) the type of support offered, 3) the stability of support in terms of permanence and long term expectations, and 4) the characteristics of the agricultural sector being targeted by the program and the primary assets used in agricultural production.

From the theory of asset capitalization the key criteria is the amount of cash transferred to farmers through the program and the rate used to discount these cashflows in the long-run and in the short-run. Theory would suggest that the larger the cash flows the more farmers can bid for land and provide a reasonable rate of return to assets, equity, and risk bearing.

The notion of risk bearing is also very critical. The more variable are cash flows from any source, the greater will be the risk premium. In other words, the appearance of uncertainty in future cash flows is sufficient to dampen the rate at which cash flows are capitalized into land values.

Income transfers from farm programs and risk perception are related. In order for substantial capitalization to take place farmers must view the programs as being stable. For example ad hoc assistance which is neither anticipated, nor expected to continue would not ordinarily give rise to substantive increases in asset values. Alternatively structured programs such as the Agricultural Stabilization Act, National Tripartite Stabilization Plans, the Farm Income Protection Act, or supply management, would provide a reasonable perception of permanence and income transfers to have a significant impact on asset values. Even if expected program benefits do not exceed farmers' contributed premiums (i.e. no net cash transfers) land markets could still respond to anticipated reduction in risk.

4.1. Net Transfer to the Farm Sector for Ontario and Saskatchewan:

Table 4.1 shows the net transfers of various government programs from 1989 to 1993 for Saskatchewan and Ontario and Table 4.2 shows them on a per acre basis. The major program categories are GRIP, NISA, Provincial Stabilization programs, agricultural stabilization payments, crop insurance, dairy subsidies, and other payments. Each one of these program provides transfer benefits to farmers, but the extent to which these are capitalized into land or asset values differs.

Table 4.3 identifies key characteristics which can affect land capitalization. As can be seen from Table 4.3, the reliability of the program is just as important as the income enhancing and risk reducing attributes of the program. GRIP for example, was legislated with a 5 year life which may have been sufficient for farmers to view the program benefits as being reliable both in terms of its income enhancement and risk reduction attributes. Income enhancement arises from the actuarial structure of the program which provides farmers with an expected benefit which exceeds costs, and since the program is commodity specific, benefits can be received regardless of the economic performance of other crops grown. These characteristics suggest that capitalization of program benefits under GRIP would be high. Similar attributes are found with NTSP. However with NTSP the impact on land values would be more significant for cash crops and beef, than for other commodities such as hogs. (Benefits from NTSP on hogs are more likely be capitalized into farm assets like buildings, burns etc. than on land).

In contrast, *ad hoc* assistance through disaster relief or other programs does not provide a reliable source of cash. In specific instances these programs are income enhancing. For example in 1989, Saskatchewan farmers netted $489 million, but this fell to $292 million in 1990 and to $85 million in 1991. Support level under various *ad hoc* programs increased to $233.5 million in 1992 and then dropped sharply to $15.5 million in 1993. Long-term investment (i.e., land purchase) decisions cannot be based on such widely fluctuating and less reliable source of income. Note that in Ontario only a small proportion of total program payments came from various *ad hoc* programs (Tables 3.1 & 3.2). So, the influence of these programs on land values is expected to be lower in Ontario than in Saskatchewan.

Dairy subsidies in Ontario and Saskatchewan are low in relation to total transfers making up 20% and 1% respectively in 1993. From an economic perspective, dairy subsidies would have a much greater impact on asset capitalization in Ontario than in Saskatchewan. However, it is unclear as to what impact these transfers would have on land values since most benefits from dairy subsidies, and supply management would be expected to be capitalized into quota values since dairy subsidies provide a significant contribution to cash flow, while supply management itself produces a significant reduction in risk.

Table 4.1: Net Transfers to Producers, Saskatchewan and Ontario, 1989-1995[a]

	1989	1990	1991	1992	1993
Saskatchewan ($ Millions)					
Gross Revenue Insurance Plan	0	0	233.2	342.4	342.1
Net Income Stabilization	0	0	35.4	131.7	55.5
Western Grain Stabilization	58.6	-70.7	29.0	-7.3	7.7
Provincial Stabilization Programs	34.4	2.4	0.7	0	0
Price Stabilization Payments	0.02	0	0	0	0
Tripartite Payments	34.4	1.0	.9	18.4	-2.4
Crop Insurance	360.5	199.6	-3.6	67.1	139.3
Dairy Subsidy	7.0	6.8	6.3	6.1	5.5
Other Payments	489.4	291.8	84.6	233.5	15.5
Total Payments	984.3	430.8	386.3	791.9	547.8
Ontario ($ Millions)					
Gross Revenue Insurance Plan	0	0	53.1	187.2	89.5
Net Income Stabilization Account	0	0	1.6	43.8	203.8
Western Grain Stabilization	0	0	0	0	0
Provincial Stabilization Payments	17.2	8.6	15.6	26.0	1.2
Price Stabilization Programs	47.3	0.8	17.7	9.8	0.01
Tripartite Payments	152.1	17.8	9.8	89.1	-7.4
Crop Insurance	15.9	-4.9	12.6	-0.6	138.9
Dairy Subsidy	85.3	83.7	79.1	72.2	70.0
Other Payments	82.9	36.6	28.0	96.6	27.4
Total Payments	400.9	142.6	217.6	524.1	339.9

[a] Net transfers after producer contributions

[b] Excludes rebates

Table 4.2: Net Transfers per Acre to Producers by Programs, Saskatchewan and Ontario: 1989-93					
	1989	1990	1991	1992	1993
Saskatchewan ($/Acre)					
Gross Revenue Insurance Plan	0	0	3.51	5.15	5.13
Net Income Stabilization	0	0	0.53	1.98	0.83
Western Grain Stabilization	0.89	-1.07	0.44	-0.11	-0.12
Provincial Stabilization Programs	0.52	0.04	0.01	0	0
Price Stabilization Payments	0.0003	0	0	0	0
Tripartite Payments	0.52	0.02	0.01	0.28	-0.04
Crop Insurance	5.46	3.01	-0.05	1.01	2.09
Dairy Subsidy	0.11	0.10	0.09	0.09	0.08
Other Payments	7.41	4.41	1.27	3.51	0.23
Total Payments	14.91	6.51	5.82	11.92	8.21
Ontario ($/Acre)					
Gross Revenue Insurance Plan	0	0	3.94	14.00	6.74
Net Income Stabilization Account	0	0	0.12	3.27	1.53
Western Grain Stabilization	0	0	0	0	0
Provincial Stabilization Payments	1.26	0.63	1.16	1.94	0.09
Price Stabilization Programs	3.47	0.06	1.32	0.73	0.0004
Tripartite Payments	11.14	1.31	0.73	6.66	-0.55
Crop Insurance	1.17	-0.36	0.94	-0.05	10.45
Dairy Subsidy	6.25	6.17	5.88	5.40	5.27
Other Payments	6.07	2.70	2.08	7.22	2.06
Total Payments	29.34	10.51	16.15	39.18	25.59

a. Net transfers after producer contributions; b. Excludes rebates

Table 4.3: Basic Program Features and Revenue Enhancing and Risk Reducing Characteristics of various Farm Programs in Canada				
	Program Features	Revenue Enhancing	Risk Reducing	Degree of Capitalization
GRIP	• Price and/or revenue protection • Commodity specific • Duration fixed; quasi permanent • Support based on average prices or revenues • May have yield offsets such as Saskatchewan	• High • Farmers pay only 33% of premiums	• High • Indemnities paid on low prices • Higher for Ontario because of yield offsets	• High • Viewed as long-term program • Income enhancing • Risk reducing
NISA	• Based on net eligible sales • Producers contribute 2% to NISA savings account to $5,000 maximum • Matched by government • Additional contributions of 20% to max. of $50,000 can be made • 3% interest bonus on NISA accounts • Withdrawal can be triggered by income falling below the threshold • Whole farm program, not commodity specific • Somewhat similar to RRSP in terms of tax savings and retirement withdrawals	• Low • Withdrawals are from savings account • Savings account buffers income and consumption • NISA account may be viewed as source of liquidity but can't be used for land purchases	• Medium • Withdrawals based on whole farm • Revenues decreases from one enterprise can be offset by increases in another • Reduces liquidity risk, and modest reduction in business risk • Does not reduce financial or investment risk to a large degree	• Low • Timing of cash withdrawals uncertain • Contribution to NISA account is a use of cash • Capital gains and investment income accrue to savings account • Farmers can't rely on NISA account to service debt on land purchases
WGSA	• Available only to Western provinces • Producers premiums in effect • Payouts based on performance of basket of grains and oilseeds	• Low in recent years • Historically significant	• Medium to high • Depends on correlation between grain crops and basket of crops • Benefits and risk reduction higher for crops with high systematic risk • Indemnities unpredictable	• Medium to high • Not all producers benefit to some degree • Interim and final payments not announced in advance - unpredictable • Existence of program may be sufficient to increase land prices
Provincial Stabilization Programs and Price Stabilization	• Differs by province • Usually of short-term duration • May or may not require producer contributions • Commodity specific	• High	• Modest • Depends on duration of program level of protection	• Low • Payouts may not be announced • Cash flows unreliable for future source of cash
National Tripartite Stabilization	• Commodity specific • Targeted towards red meats and cash crops • Support based on guaranteed margin • Cost shared by producers and governments	• High • Producers pay only 33% of expected benefits • Interim payments provide security	• High • Payouts based on margin • Indemnities reduce downside risk	• High • Indemnities are reliable • Cash benefits exceed producer costs • Program provides downside risk reduction

Table 4.3: Continued.

	Program Features	Revenue Enhancing	Risk Reducing	Degree of Capitalization
Crop Insurance	• Commodity specific • Programs differ by province • Indemnities based on yield shortfalls below target yield, and based on expected or elected price	• Modest high • Indemnities based on individual farm but premiums may be based on provincial or area averages - premiums and benefits may be mismatched	• Modest to high • Depends on coverage level and farm risks • Risks regionally specific • More valuable for high risk crops • Coverage levels may be too low in some regions	• Modest • Depends on actuarial soundness at farm level • Provides expected income enhancement • Provides reliable source of security
Dairy Subsidy	• Federal transfer to dairy producers for fluid milk • Companion program to supply management	• High	• Low • Subsidy itself is low • Risk reduction due to supply management is high	• Little impact on land value but can be significant for quota values • Impact of supply management high
Other Programs	• Typically ad hoc programs (e.g. draught assistant, disaster assistance) • Provincially and federal programs included	• High • Payments high but unreliable and not persistent	• Modest to high • Program features provide disaster relief on ad hoc basis • Farmers may view ad hoc programs as long run policy, but ad hoc policies do not provide sufficient history for risk taking	• Modest • Depends on reliability of programs • Timing of payment uncertain • Cash flows for debt and investment servicing unreliable • No program guarantees can minimize impact of risk reduction

4.2. The Welfare Effects of Government Transfer Programs and Asset Capitalization:

The notion that government programs are capitalized into land and other asset values can have significant impacts on consumer and producer welfare. Of particular concern is the impact of capitalization on land values and quota.

Figure 4.1 is a simple representation of the welfare impact and capitalization effects on land values. In the long run it is assumed that the supply of land is perfectly inelastic, and the impact of subsidies is to shift the demand curve to the right. In contrast to non capital inputs such a shift does not necessarily reflect an increase in production or output. Furthermore, the concept of consumer surplus is not well established since the consumers of land are future farmers.

In this view an increase in producer surplus reflects a pure capital gain to existing land owners, while the decrease in consumer surplus reflects a decrease in benefits to future farming generations. For example in Figure 4.1 the area bounded by P_obQ0 represents static producer surplus in the form of asset values. If these existing farmers receive a transfer which is viewed as being permanent and these transfers are capitalized into land values then the demand curve shifts from D_o to D_1. With a perfectly inelastic supply the land price increases to P_1. The area $P_oP_1$ab reflects the increased asset value which is pure capital gains. This same area represents a decrease in consumer surplus. This decrease occurs because the next generation of buyers must pay current land owners for all the future benefits of the increase in program benefit. That is, even though farmers receive an income transfer while farming the land, they also receive the present value of all future transfers upon sale of the land. The next generation of farmers, while receiving the transfer payments in cash has, by purchasing the land at P_1 rather than P_o, transferred those benefits to the last generation, and do not therefore benefit from the program. The natural consequence of this is that further transfer payments may be required, and the demand curve could ratchet upwards.

Quota prices behave quite differently. The value of dairy quota is derived from the underlying demand function for milk which is priced in excess of marginal costs. As shown in Figure 4.2 the area bounded by PabMC, where MC is the marginal cost and P the net milk price received, represents pure economic rents or profits. Quota provides the right to obtain these economic profits and it is this area which is capitalized into quota values in the short run.

As Quota prices increase the marginal cost curve shifts to the left and become steeper (more inelastic supply of milk under autarky). The result is shown in Figure 4.2 which assumes that P is held constant, and the demand for milk does not change. The area bounded by abo represents a capital gain to initial holders of quota, and a loss of consumer surplus to next generation quota holders. In essence the area abo becomes a direct transfer from the next generation of quota holders to the current generation. A result of this transfer is increased marginal costs represented by a shift in the original marginal cost curve from MCO to MC1.

Figure 4.1

Figure 4.2

5. ESTIMATION: ISSUES & METHODS

5.1. Estimation Issues:

If we assume that

…[economic] agents live forever in an exchange environment, discount the future at a constant discount rate, have time separable utility functions characterized by risk neutrality, value assets only for the returns they generate, behave competitively and face no distortionary taxes. (Hamilton and Whiteman, 1985, p.372),

then the value of a parcel of land at a given point in time is equal to the sum of all discounted future net returns from that land. This is equivalent to the land valuation model presented in Equation (3.1). This type of land valuation model has been the subject of considerable empirical investigation. As mentioned in the literature review section, such a simple land valuation model has been expanded through time to include a number of factors other than net farm incomes.

However, much of the early literature estimated the relationships between land price and various explanatory variables using traditional regression methods. This literature also includes some recent work such as Alston (1986), Burt (1986) and Weisensel, Schoney and van Kooten (1988) and Veeman, Dong and Veeman (1993). If the data are characterized by unit root nonstationary, it is now well known that such methods may suffer from the spurious regression problem originally studied by Granger and Newbold (1974). In addition, the concept of cointegration in the sense of Engle and Granger (1987) between land price and a set of explanatory variables becomes an important empirical consideration when unit roots characterize the data. As mentioned previously, Campbell and Shiller (1987) rigorously demonstrate the relationship between unit root non-stationarity and cointegration within the context of present value models. The following section provides a brief introduction to unit root testing and cointegration analysis.

5.2. Cointegration Analysis: An Introduction

The concept "cointegration" is one of the most important developments in the econometric literature during the last decade. During a relatively short time period, cointegration analysis has almost completed a long journey from the tool kits of fashionable econometrician to those of general practitioners. Cointegration is a statistical property originally introduced by Granger (1981) which can describe the long-run behaviour of economic time series. The current popularity of cointegration analysis, however, is attributed to a seminal paper by Engle and Granger published in Econometrica in 1987. Since the publication of this article, a substantial body of work involving cointegration analysis (both theory and applications) has appeared in leading economic, econometric and statistical journals. It's acceptability among empirical economists has increased substantially in recent years and it is quickly becoming a standard econometric methodology for empirical studies involving time series data.

It is well known that most economic time series are not stationary in their levels. That is, both the mean and variance of these series are not constant over time. In the past, differencing and time trend removal have been used to make nonstationarity time series stationary. Developments in statistical distribution theory during the seventies and eighties made it possible for econometrician to identify a number of serious problems associated with traditional regression analysis with nonstationary data. Notable among these problems is the possibility of spurious or nonsense regression among the levels of nonstationary economic variables (Granger and Newbold 1974). The estimated parameters from a regression involving nonstationary variables will not be consistent unless the variables are somehow related to each other over the long-run. Also important from an inference point of view, is that the error terms resulting from standard regression analysis of nonstationary variables do not follow a standard normal distribution even asymptotically. Consequently, the conventional statistical tests such as t, Z, F etc. are not valid. This has far reaching implications for empirical economic research; namely, inappropriate or misleading inferences or conclusions could be generated from standard test results.

The point of departure of cointegration theory is the proposition that if the nonstationary variables are integrated of order one or they have unit roots (i.e., they are I(1))[4], then it is possible that some linear combination of these nonstationary variables are stationary. If this is true, then the variables are called cointegrated. When some economic variables are cointegrated, they cannot move too far apart from each other in the long-run, although their levels seem to fluctuate widely in the short-run. This property of the cointegrated variables fits perfectly with the theoretical notion of a long-run relationship among economic variables. Cointegration analysis, therefore, links the concept of equilibrium relationships among economic variables embedded in economic theory to a statistical model of equilibrium among those variables. It turns out that, in doing so, it provides a theoretically consistent and econometrically more efficient approach to test economic hypotheses than has been the case in the past. It is perhaps due to this attractive feature that cointegration analysis has gained enormous popularity in recent years. The statistical theory of unit-root processes provides the basis for statistical inference about the existence of cointegrated relationships in empirical analysis. If a group of economic variables are cointegrated, then, by **Granger's Representation Theorem**, there must exist an error-correction representation of the relevant variables (Engle and Granger 1987). Through this relationship with error-correction models, cointegration analysis generates both short-run and long-run information from data. Notice, however, unlike conventional econometric analysis, the long-run relationships in cointegration analysis are generated independently of the short-run relationships. The long-run relationship is a stable steady state relationship and the short-run relationships represent deviations around this equilibrium relationship. Through correcting these short-run deviations or errors, the relevant economic system approaches its long-run path. Hence, the term error-correction models.

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[4] In general, a variable X_t is said to be integrated of order d [or $X_t \sim I(d)$] if it has a stationary representation after differencing d times. Thus, an I(1) variable becomes stationary after first differencing. The variance of an I(1) variable is time dependent; it goes to infinity as time goes to infinity. The underlying Data Generation Process (DGP) of an I(1) variable also has an infinitely long memory. Thus, a shock or disturbance will permanently affect the process.

5.3. Testing for Cointegration:

Since there is a close correspondence between tests for unit roots and tests for cointegration and since cointegration is most interesting among I(1) variables, it is useful to begin the analysis by considering whether or not the univariate time series have unit roots. In particular, it is necessary to show that unit root nonstationarity characterizes the univariate representation of each variable under consideration if cointegration analysis is to take place. A number of tests have been proposed in the literature to test for the presence of unit root nonstationarity. Notable among these tests are the Dickey-Fuller test or the Augmented Dickey-Fuller test, the Phillips-Perron test and Kwiatkowski et al. test (see Dolado et al., 1990, Kwiatkowski et al., 1992, Clark et al., 1993, and Davidson and MacKinnon 1993 for details on these tests). The first three of these tests investigate the null hypothesis that the series has a unit root against a stationary around a time trend alternative while the last one tests the null hypothesis that the series is stationary around a linear trend against the unit root alternative. Thus, for a given series, if the first three tests are accepted and the last test is rejected, it would imply that the series is characterized by a unit root nonstationarity.

If the results from above tests reveal that all variables under investigation have a unit root, then the next step is to find out if there is any linear combination of these nonstationary variables which is stationary. In other words, if the variables are cointegrated and how many stable long-run cointegrating relationships are there. When cointegration is found among I(1) variables, the model implies a good fit. This happens because the nonstationary part of each series, which is the dominating portion of the series, has been explained by the nonstationary parts of other series. This is why it is very important to find cointegrated relationships among nonstationary economic variables. In absence of any cointegrated relationships among I(1) variables, the part dominating the series remains unexplained and the empirical performance of the model is likely to be poor.

Six major testing procedures have been proposed in the literature for testing cointegration. These are: (i) the Dickey-Fuller (DF) test on cointegration regression residuals (Engle and Granger 1987); (ii) the cointegration regression Durbin-Watson (CRDW) test (Engle and Granger 1987); (iii) the Park J_1 superfluous variable addition test using the canonical cointegration regression (Park 1990, 1992); (iv) the Hansen fully modified regression estimator L_c test (Hansen 1992); (v) the dynamic OLS procedure developed for testing common trends (Stock and Watson (1988); and, (vi) the maximum likelihood cointegration approach (Johansen 1988, 1991). The first five tests are based on some variation of regression analysis (conventional and modified), while the last one is based on an unrestricted vector autoregression model. While the DF test and the CRWD test are easy to implement, the others are more difficult to operationalize. For a comparison of the performance of the major approaches to cointegration analysis, see Dickey et al., (1991) and Gonzalo (1994).

Studies that have used vector autoregression and cointegration analysis in empirical investigation of the land valuation problem include Phipps (1984), Falk (1991), Clark, Klein and Thompson (1993), Clark, Fulton and Scott (1993), Baffes and Chambers (1989) and Ahrendsen and Khoju (1994). There have also been a few studies that have used other, newly developed, estimators to study land valuation. These include the generalized methods of moments estimator developed by Hansen (1982) (Goodwin and Ortalo-Magne (1992)) and Hamilton's estimator under regime switching (1990).

6. DATA DESCRIPTION

The data set for Ontario consists of annual observations on direct government subsidies (both federal and provincial) per acre, income from farm operations (on cash basis) per acre and land values per acre from 1947 to 1993. All data came from Statistics Canada Catalogue #21-603E (Agricultural Economic Statistics). Data on direct subsidies include payments under: (i) crop insurance program, (ii) ASA-Price Stabilization, (iii) ASA-Tripartite plans, (iv) provincial stabilization programs, (v) dairy subsidy, (vi) NISA, (vii) GRIP, and (viii) other federal and provincial programs designed to deal with unusual climate (e.g., drought or frost etc.) or economic conditions (e.g., very low commodity prices, trade war etc.) affecting agriculture. The Canadian implicit GNP price deflator (1987=100), taken from the Canadian Statistical Observer, 1993, has been used to obtain data in constant dollars.

The data used for Saskatchewan are annual observations from 1949 through 1993. Data on land values per acre and total income per acre are taken from the Agricultural Statistics of Saskatchewan Handbook, 1993. Data on subsidies are taken from Statistics Canada, Agricultural Economic Statistics, 1993. The subsidy data for Saskatchewan include payments under the following programs: (i) Temporary Wheat Reserves Act, (ii) Two-Price wheat program, (iii) Canadian Wheat Board losses in the pools, (iv) Western Grain Transportation Act (formerly subsidies were paid to the railways under the Crow's Nest Pass Agreement), (v) Crop insurance, (vi) Special Canadian Grains Program, (vii) Western Grain Stabilization Act and payments under GRIP and NISA. Note that all program payments are net of farmers contribution. All data are deflated by the Canadian implicit GNP price deflator (1987=100), taken from the Canadian Statistical Observer, 1993. The subsidy data are subtracted from the income data to arrive at an income figure that does not include subsidies.

Figures 6.1 through 6.6 graphs the data for Ontario (Figures 6.1 through 6.3) and Saskatchewan (Figures 6.4 through 6.6) for land prices, income per acre and subsidies per acre. For land values (Figures 6.1 and 6.4), the same basic pattern is observed for both series until 1982, with both series exhibiting an upward trend. After that time period, however, the series diverge, with the Ontario series falling off and then rising again and the Saskatchewan series falling.

For the subsidy data, the same pattern emerges for both provinces (Figures 6.2 and 6.5). In this case, the subsidy series rises only slowly during the first part of the sample and then rises rapidly during the 1980's. However, after 1990, the subsidy data falls for Saskatchewan and does not fall in Ontario.

The biggest difference between the series is in the income series (Figures 6.3 and 6.6). For Ontario, farm incomes rise during the first part of the sample and then fall after 1986. For Saskatchewan, the income series is much more erratic. This series does not seem to trend at all from the period 1949-1970, rising rapidly after that and then falls again in the early 1980's.

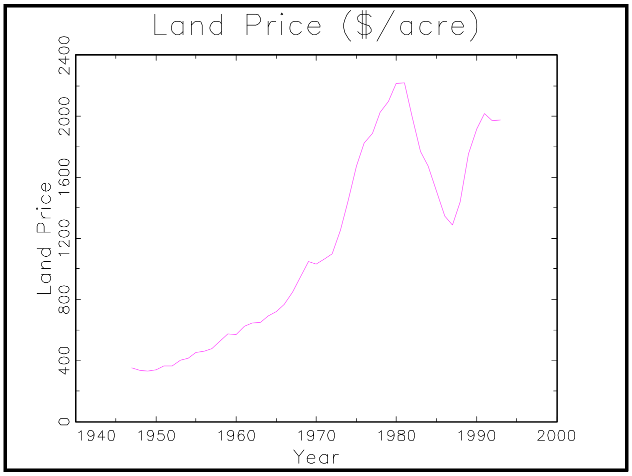

Figure 6.1: Land Price per Acre

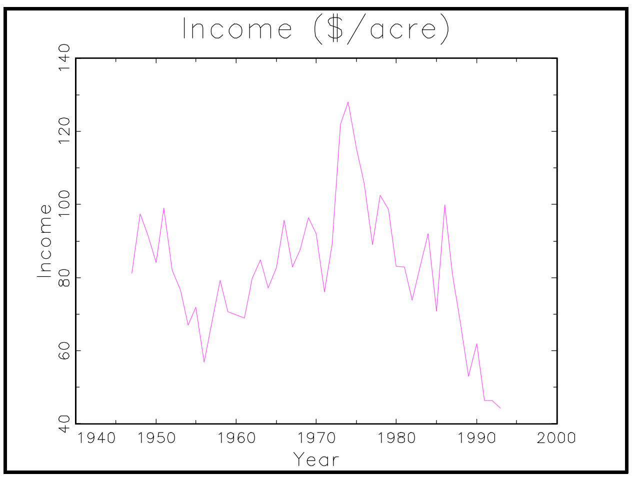

Figure 6.2: Production Income per Acre

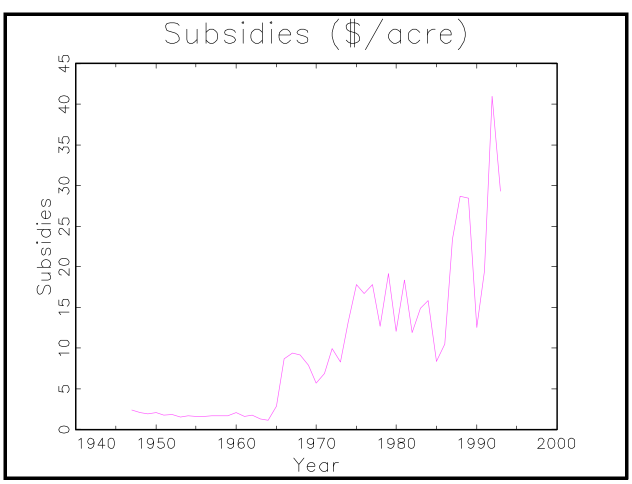

Figure 6.3: Government Subsidies per Acre

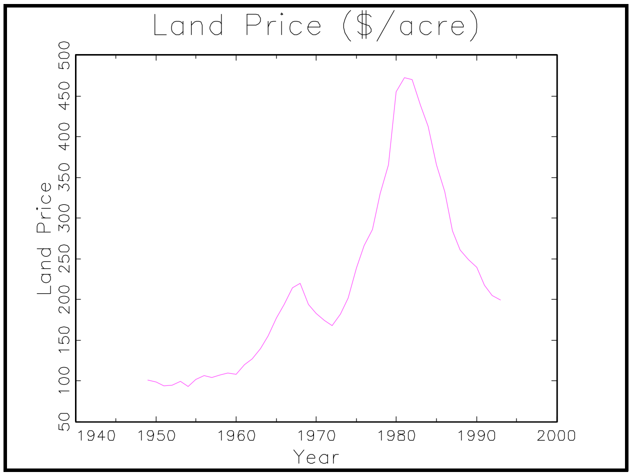

Figure 6.4: Land Price per Acre

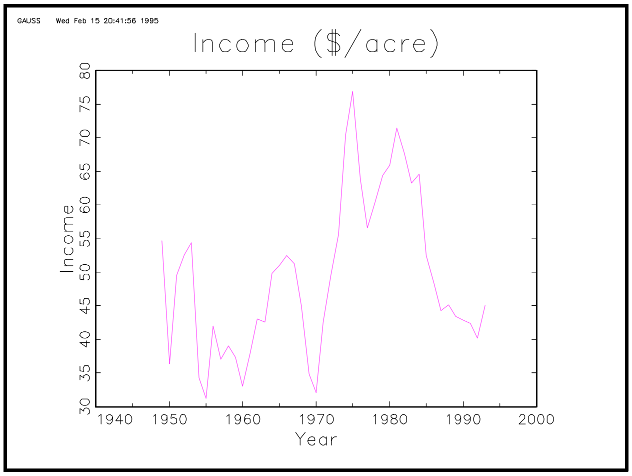

Figure 6.5: Production Income per Acre

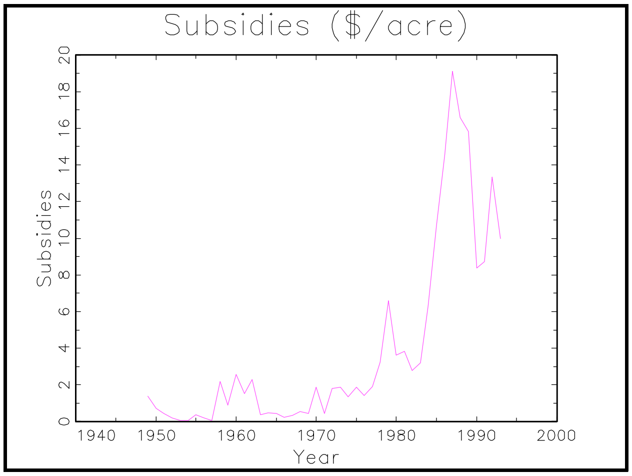

Figure 6.6: Government Subsidies per Acre

7. EMPIRICAL RESULTS

7.1. Time Series Properties of the data:

In order to estimate the parameters of the models presented in previous sections, it is necessary to establish the proper time series properties of the data. As is now well known (e.g. Engle and Granger (1987)), if the data contain unit roots, then the estimation of the relevant relationships is radically different from standard regression techniques. Table 7.1 presents tests for unit roots in the series for the provinces of Saskatchewan and Ontario. Two tests are presented 1) the Dickey-Fuller test and the Phillips Perron test.[5] The table indicates that in all cases except for subsidies the hypothesis of a single unit root cannot be rejected. This indicates that unit root non-stationarity seems to be consistent with the data and the data can be used in a structural model of land value.

7.2. The Long-Run Results:

Since all of the series seem to be consistent with a single unit root, we proceed to test for cointegration among them. The cointegrating relationship identifies that long-run relationship that exists among non-stationary time series (Engle and Granger (1987)). Therefore, the cointegrating relationship can be used to identify the long run discount rate used to capitalize assets as well as long-run elasticities of land prices to changes in subsidies and income.

Another test of interest is to test for equality of response of land prices to income and subsidies. If this test is rejected, then the empirical evidence would support the notion that the manner in which subsidies are capitalized into land prices is different than that for income. In other words, income from the two different sources is viewed differently by economic agents when they make capitalization decisions.

Table 7.2 presents the results of estimating the cointegrating relationship among land prices, income and subsidies for Ontario. The canonical cointegrating regression (CCR) developed by Park (1992) is used to estimate and test the cointegrating relationship.[6] Since the choice of regressand is arbitrary, the relationship is estimated using all three regressors (land prices, income per acre and subsidies per acre) as regressands.

In the bottom part of Table 7.2, Park's (1990) J_1 variable addition test is used to test for a cointegrating relationship. The test results indicate that there is only one cointegrating relationship

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[5] For a general description of these tests, see Appendix A.

[6] A brief description of the Canonical Cointegration Regression procedure is given in Appendix B.

among the variables for Ontario (when land price is the regressand). This conclusion is reached because the J_1 test is not rejected when land price is chosen as the regressand for Ontario but is rejected when either income per acre or subsidies per acre are chosen as the regressand. These results along with those of Dickey-Fuller and Phillips-Perron tests imply that a stable long-run relationship exists among land price, income and subsidies. The results reject the notion that land values caused either income or subsidies. The results are very much consistent with what should be expected in a land capitalization model.

Finally, the equality of the coefficients of income and subsidy variables was tested. The test reject the hypothesis that income and subsidy variables have identical influence on land price in Ontario. This indicates that in Ontario producers view income obtained through government subsidies as different from market generated income when they make land capitalization decisions.

In the case of Saskatchewan the results of estimating the cointegrating relationship are presented in Table 7.3. The table shows that the J_1 test is not rejected for any case. Based on these results we conclude that there is evidence in favour of three cointegrating relationships among the variables for Saskatchewan. Park and Ogaki (1990) argue that the choice of regressand should be made so that the parameters are estimated linearly. This criterion would favour the choice of cointegrating relationship when land prices are chosen to be the regressand. This advice is followed in this report.

In contrast to Ontario, Table 7.3 shows that for Saskatchewan, the test of equality of coefficients in income and subsidies cannot be rejected. This evidence is consistent with the view that revenues from markets and government programs are capitalized similarly in land values. This result is likely due to different perceptions about the permanence of farm programs, which in the case of Saskatchewan have been *ad hoc* in nature. So, like income from production, income from various program subsidies has been an unreliable source of farm cashflow in this province.

Table 7.4 presents the estimated discount rates and long-run elasticities of land price with respect to income and subsidies. The estimated coefficients of the chosen cointegrating relationships from tables 7.2 and 7.3 are used to obtain long-run discount rates and elasticities. In particular, the long-run discount rates are obtained by imposing the steady-state on the constant discount rate version of the capitalization model. If this is done then the coefficient on the income variable in the cointegration regression is 1/r, where r is the long-run discount rate. The elasticities are calculated the usual way: take the coefficient and multiply it by the mean of the variable divided by the mean of land price. The table shows that the estimated long-run discount rates for Ontario is 8.7%. The estimated income and subsidy elasticities of land price are similar and inelastic, being 0.91 and 0.73, respectively; for every 1% increase in income land values will increase by .91% in the long-run, and for a 1% increase in subsidies implies a long-run capitalized increase in land values of only .73%.

Table 7.1: Unit root tests on Series for Ontario and Saskatchewan			
	Series		
Test	Land Price per acre	Income per acre	Subsidies per acre
1) Saskatchewan			
Dickey-Fuller	-1.75 (3)	-2.15 (0)	-1.19 (0)
Phillips-Perron	-1.39 (3)	-2.28 (1)	-1.25 (1)
2) Ontario			
Dickey-Fuller	-1.00 (2)	-2.04 (0)	0.36 (3)
Phillips-Perron	-1.22 (2)	-1.95 (1)	-1.11 (3)

Values in parentheses underneath test statistics are:
1) For Dickey-Fuller: number of lagged differences included in regression.
2) For Phillips-Perron: lag truncation length.
The critical value for the Augmented Dickey-Fuller test and the Phillips-Perron test at 5% level of significance is -3.14.

Table 7.2: Canonical Cointegrating Regression Results for Ontario (1947-1993)*			
	Regressand		
Regressor	Land Price	Income	Subsidies
Land Price	1.0	0.033 (2.75)	0.0121 (10.57)
Income	11.47 (2.26)	1.0	-0.152 (-3.36)
Subsidies	72.97 (8.93)	-2.635 (-2.73)	1.0
Intercept	-455.56 (-1.05)	69.88 (7.77)	83.05 (2.04)
$J_1(1)$	11.28[c]	2.10	0.15
$J_1(2)$	12.69[c]	3.06	3.48
$J_1(3)$	16.13[c]	7.70[c]	3.51
test $b_1 = b_2$	171.39[c]	-1.70	18.72[c]

*Values underneath parameter estimates are t-values. [c] indicates significant to the 10% level.
n.a. not applicable.
The J_1 tests are distributed as Chi-squared with the degrees freedom given in the parenthesis.
The critical values are 3.841, 5.991 and 7.815 at 10% level of significance with dfs. 1, 2 and 3 respectively.
The individual coefficients follow the asymptotic normal distribution.

Table 7.3: Canonical Cointegrating Regression Results for Saskatchewan (1949-1993)*				
	Regressand			
Regressor	Land Price	Income	Subsidies	Land Price
Land Price	1.0	0.086 (5.05)	0.0512 (4.73)	1.0
Income	7.387 (4.47)	1.0	-0.341 (-2.73)	n.a.
Subsidies	11.820 (2.36)	-0.495 (-1.06)	1.0	n.a.
Income plus Subsidies	n.a.	n.a.	n.a.	8.949 (4.81)
Intercept	-200.47 (-2.14)	32.12 (8.27)	9.82 (2.07)	-257.22 (-2.47)
$J_1(1)$	0.838	0.000	0.003	0.097
$J_1(2)$	1.08	0.002	1.56	1.03
$J_1(3)$	2.80	0.960	1.89	1.24
test $b_1 = b_2$	1.21	2.93	23.82[c]	n.a.

*Values underneath parameter estimates are t-values. [c] indicates significant to the 10% level. n.a. not applicable.

Estimates from Saskatchewan are presented for the case where the coefficient on income and subsidies are the same (hereafter called the restricted model) and when they are not (hereafter called the unrestricted model). For the unrestricted model, the estimated long-run discount rate of 13.5% is higher than that estimated for Ontario (Table 7.4). Under the restricted model, the estimated discount rate is somewhat smaller at 11.2%. These discount rates suggest that relative to Ontario, a substantially higher risk premium is required to hold land in Saskatchewan. This result is consistent with the uncertainties of Prairie incomes and programs.

With respect to the elasticity estimates, the elasticity of income is elastic at 1.67 and inelastic for subsidies at 0.86. Both of these elasticities are higher than those estimated for Ontario (see Table 7.4). These results indicate that land prices are expected to be more volatile due to changes in income and subsidies in Saskatchewan than in Ontario.

7.3. The Short-Run Results:

The estimated results from the cointegrating relationship can be used to estimate the short-run response of land prices to (changes in) income and subsidies. This type of model is known as the error correction model in the time series literature (e.g. Engle and Granger (1987)). In the error correction model, a vector autoregression (VAR) of the errors from the cointegrating relationship, changes in income and changes in subsidies is estimated. The particular type of form of the error correction model estimated in this study is:

$$Model1: \quad u_t = A(L)u_{t-1} + (D_1)R_{t-1} + D_2)S_{t-1})()R_{t-1} +)S_{t-1}) + v_t$$

This model estimates time varying (short-run) discount rates as developed in a study by Turvey, Chyc and Weersink (1993). The above model can be written in unrestricted form as:

$$Model2: \quad u_t = A(L)u_{t-1} + B_1)R^2_{t-1} + B_2)S^2_{t-1} + B_3)R_{t-1})S_{t-1} + e_t$$

Model 1 reduces to model 2 when $B_3 = B_1 + B_2$. This test can easily be performed and the restricted model estimated.

The estimated restricted short-run models are presented in Table 7.5. The results indicate that the restrictions placed on the model are not rejected for Ontario or Saskatchewan. We conclude that the Turvey, Chyc and Weersink (1993) model, which relates to equation (3.3), is consistent with Ontario land price data and Saskatchewan land price data.

Table 7.5 also shows that the short-run response of discount rates to changes in income squared is negative in both provinces, with the Ontario coefficient being higher (in absolute

Table 7.4: Estimated long run interest rate, long run elasticity of income and long run elasticity of subsidies for Saskatchewan and Ontario*

	Province		
	Ontario	Saskatchewan	
Variable		Income & Subsidies Separate	Income + Subsidies Combined
Interest rate	8.70%	13.50%	11.20%
Elasticity of Income	0.909	1.67	n.a.
Elasticity of Subsidies	0.732	0.86	n.a.
Elasticity of Income + Subsidies	n.a.	n.a.	2.17

* Elasticity measures evaluated at the mean of the data. n.a. not applicable.

Table 7.5: Restricted Short-Run models of Land Pricing[a]

	Province	
Regressor	Ontario	Saskatchewan
Error lagged one time period	0.489 (3.43)	0.887 (6.21)
Error Lagged two Time periods	-0.316 (-1.97)	-0.345 (-2.34)
First Differenced income squared lagged one time period	0.599 (2.58)	-0.024 (-0.26)
First Differenced subsidies squared lagged one time period	-1.118 (-1.59)	0.596 (0.91)
First Differenced income times subsidies lagged one time period	-0.519 (-0.75)	0.572 (0.85)
R^2	0.32	0.54
t-value on restriction	1.33	1.08

[a] Values in parentheses underneath parameter estimates are t-values.

value) in response and more significant. Indeed, the Saskatchewan coefficient is insignificant. For subsidies, both regions show a fairly high positive response, although once again the Ontario coefficient is the only coefficient with a large t-value. In both cases the R^2 value of 0.32 for Ontario and 0.54 for Saskatchewan implies an adequate fit of the overall model specification.

7.4. Results of Estimation of the Quota Model:

The procedures of the previous section were also applied to milk quota values (unused MSQ type) for Ontario milk producers. The data were available on a monthly basis from August, 1980 through July, 1994. Data were not available for subsidies and income separately, so the analysis is undertaken with a single aggregate subsidy plus income variable, hereafter simply called income.

Figures 7.1 and 7.2 graph the data. From figure 7.1, it is evident that quota values tended to rise from 1980 through 1986 and then fall until 1990. Thereafter, a general rise is discernable. Overall, the quota values seem to indicate a general positive trend. For income, the series seems to fall from 1980 through 1992 with a slight rally thereafter.

The results of the unit root testing on the model and the cointegration regression results are presented in Table 7.6. The results presented at the top of this table are the Dickey-Fuller and Phillips-Perron unit root tests. These tests are consistent with unit root non-stationary characterizing the quota series. For income, the results are ambiguous, with the Dickey-Fuller test indicating non-rejection of the unit root hypothesis and the Phillips-Perron test indicating rejection to the 10% level of significance. However, the Phillips-Perron tests is not significant at the 5% level, so we conclude that there is at least mild evidence in favour of a unit root in this series as well.

We then proceed to test for cointegration between the series. These results are presented at the bottom of Table 7.6. The results of the Park J_1 tests indicate that the existence of a cointegrating relationship between quota values and income is strongly rejected when income is chosen as regressand. However, the results when quota values are the regressand lends mild support for the existence of a cointegrating relationship between the series. This conclusion is reached because the J_1 test of the null hypothesis of cointegration is not rejected when either one or two superfluous regressors are added to the regression but is rejected when three regressors are added.

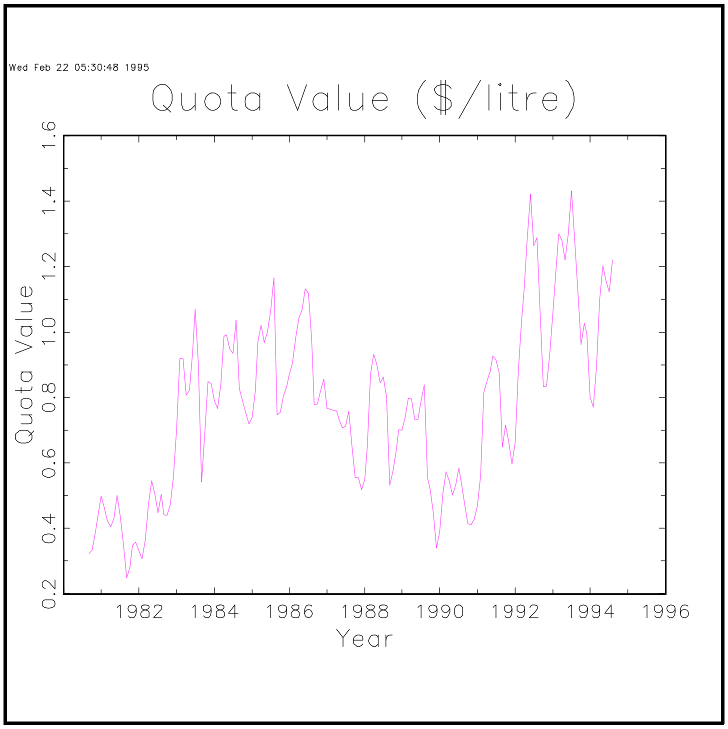

Figure 7.1: Prices of Unused Milk Quota (MSQ) in Ontario

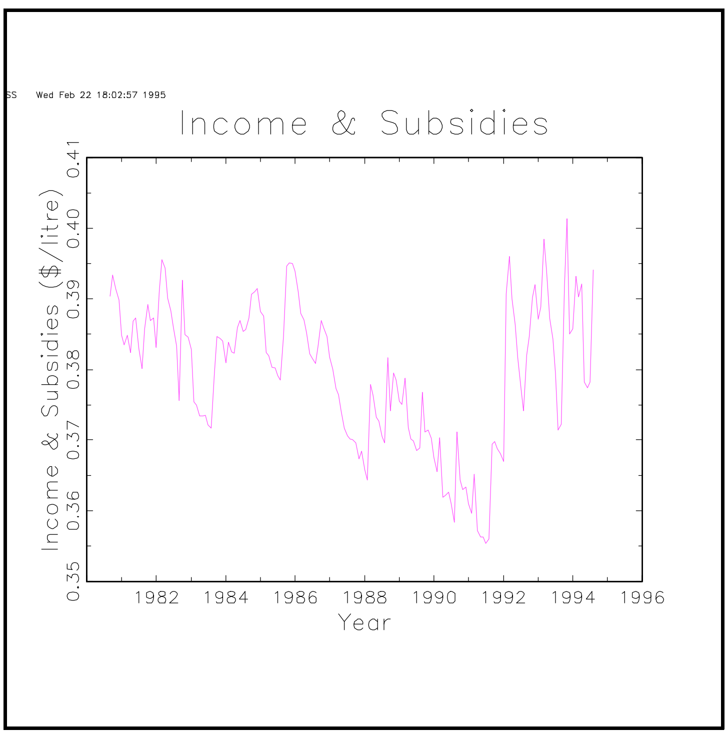

Figure 7.2: Ontario Dairy Income + Subsidies

Table 7.6: Unit Root tests and Canonical Cointegrating Regression results for Quota Series

	Variable	
	Quota Value	Income & Subsidies
1) Unit Root Tests		
Dickey-Fuller	-1.98 (12)	-1.92 (12)
Phillips-Perron	-2.17 (12)	-3.31^{c} (12)
2) Canonical Cointegrating Regression Results		
Quota value	1.0	0.037 (4.65)
Income & Subsidies	12.33 (1.98)	1.0
Intercept	-4.24 (-1.77)	0.367 (72.85)
trend	0.004 (2.84)	-0.0001 (-3.62)
$J_1(1)$	2.29	14.83^{c}
$J_1(2)$	4.76	16.33^{c}
$J_1(3)$	8.39^{c}	17.92^{c}

Values in parentheses underneath test statistics are:
1) For Dickey-Fuller: number of lagged differences included in regression.
2) For Phillips-Perron: lag truncation length.
Values underneath parameter estimates are t-values. ^{c} indicates significant to the 10% level.
The critical values for the ADF and Phillips-Perron Tests at 5% significance is -3.14.

Table 7.7: Estimated Long Run Elasticity of Subsidies on Quota Values, Estimated Long-Run Interest Rate and Short-Run model of Quota Values[a]		
	Model	
Regressor	Quota value deviation from long-run equilibrium	Estimated Elasticity and Discount Rate
Error lagged one time period	1.089 (14.05)	Elasticity at mean 6.08
Error Lagged two Time periods	-0.315 (-4.17)	Long-run discount rate=8.10%
First Differenced income squared lagged one time period	67.27 (0.50)	n.a.
R^2	0.71	n.a.

[a] Values in parentheses underneath parameter estimates are t-values.

Since there is mild support in favour of a cointegrating relationship between the series, we estimate the error correction form of the model. These results, along with estimates of elasticity of income and long-run discount rate, are presented in Table 7. The table shows that the square of lagged income is not significant in the error correction model, indicating that the Turvey, Chyc and Weersink model is not supported by this data set. The estimated discount rate of 8.10% is close to the estimated discount rate for Ontario land prices. However, in contrast to Ontario land prices, the elasticity of income is highly elastic, at 6.08.

7.5 The Structural Model:

The cointegration and error correction models just presented, verify that the relationship between land prices, income and subsidies is not spurious. Furthermore, since data are not stationary, the implication is that the discount rate is time varying. This validates the model structure outlined in equation (7.1), and the definition of discount rate outlined in Equation (7.2).

Consequently we postulate as a hypothesis to be tested that a single time-varying discount rate of the form $\delta_t(R^*_t, G^*_t)$ exists. Desirable properties of this discount rate are a) $\partial\delta_t(\bullet)/\partial G^*_t < 0$ and b) $\partial\delta_t(\bullet)/\partial R^*_t < 0$. Properties a) and b) imply that with increased expectations of future cashflows the discount rate decreases which implies that $\partial L^*_t/\partial G^*_t > 0$ and $\partial L^*_t/\partial R^*_t > 0$.

A recursive model appropriate to evaluating the time-varying discount rate is described by the following set of equations. Equation (7.3) is the reduced form structural equivalent of the error component model. It's long run equivalent value is used in adapting the Deloitte-Touche model to examine the social welfare effects of capitalization.

$$(7.1) \quad R_t^* = \alpha_1 + \alpha_2 R_{t-1} + e_1$$

$$(7.2) \quad G_t^* = \gamma_1 + \gamma_2 G_{t-1} + e_2$$

$$(7.3) \quad L_t^* = \beta_1 + \beta_2 L_{t-1} + \beta_3 L_{t-2} + (\beta_4 R_t^* + \beta_5 G_t^*)(R_t^* + G_t^*) + e_3$$

where α,γ, and β's are coefficients to be estimated and e_i are residual error terms. Equation (7.1) establishes income expectations in period t as a function of the previous period's realized income net of direct government payments and variable costs. Equation (7.2) describes policy expectations: expected direct payments in period t are based upon actual payouts in t-1. Equation (7.3) is the land expectations model comprised of lagged land values and net income expectations from production and government sources. A simple linear function, ($\beta_4 R^*_t + \beta_5 G^*_t$), is used to estimate the time-varying coefficient on the variable (R^*_t+G^*_t). As will be shown this specification of the time-varying coefficient conforms, under the null hypothesis discussed above, to the desirable features of the time-varying rate $\delta_t(R^*_t,G^*_t)$.

All equations were estimated with Shazam 7.0 (White et al) using ordinary least squares. The predicted values from equations (7.1) and (7.2) were used to provide consistent two stage least squares estimates of G^*_t and R^*_t in equation (7.3). All equations were estimated in real terms using data from 1960 through 1993 for Ontario and Saskatchewan. Data are as described in section six.

7.6. Results from the Structural Model:

7.6.1 Ontario:

The estimated model coefficients for each equation are presented below with t-statistics in parentheses.

$$(7.4) \quad R_t^* = 39.165 + .529 R_{t-1} + e_1 \qquad R^2 = .375$$
$$= (4.62) \qquad (5.22)$$

$$(7.5) \quad G_t^* = 2.096 + .8439G_{t-1} + e_2 \qquad R^2 = .661$$
$$= (1.79) \quad (1.79)$$

$$(7.6) \quad L_t^* = -.7536 + 1.467L_{t-1} - .597L_{t-2}$$
$$= (.005) \quad (12.84) \quad (-5.61)$$
$$= +(.0135R_t^* + .0734G_t^*)(R_t^*+G_t^*)+e_3$$
$$= \quad (1.88) \quad (3.35) \qquad R^2 = .984$$

OLS estimates of equations (7.4) and (7.5) are significant for the lagged R_{t-1}, and G_{t-1} variables which are, as expected, positive. The R^2 on R^*_t is quite low at 37.5% but it is high for G^*_t at 66% which may indicate that cash flows from subsidies are more reliable than those from income. As expected the predictive ability of the recursive equations is very strong with R^2 of about 98%. In Equation (7.6) the coefficient on R^*_t is positive and significant at the 10% level and the coefficient on G^*_t is positive and significant at the 1% level, providing a strong indication that these variables have an impact on land values. The hypothesis that $\beta_4 = \beta_5$ is rejected at the 10% level (Wald $\chi^2 = 1.813$) and the hypothesis that $\beta_4 = \beta_5 = 0$ is rejected at the 1% level (Wald $\chi^2 = 18.14$). The first test provides only weak evidence that G^*_t is capitalized at a different rate than R^*_t, while the second test provides strong evidence that contemporaneous cashflow expectations affect land values. This latter test implies that short-term changes in land values are not driven by purely speculative forces based solely on past land values. These results combined with the conclusions from the cointegration analysis provide strong evidence that this structural model is sound.

A final test relates to the intercept term in equation (7.6). This can be interpreted as the rational forecast of the present value of all future changes in net cashflow (Campbell and Shiller; Falk). In steady state these should theoretically be zero since a positive (negative) value implies excess (diminished) returns relative to equilibrium values (Falk). A t-statistic of -.124 confirms that the intercept is zero. This test result along with those in the previous paragraphs, imply that the time-varying discount rate model more satisfactorily appeals to a steady-state model than the constant discount rate model.

In steady state (7.6) can be reformulated as

$$(7.7) \quad L_t^* = (R_t^*+G_t^*) \Big/ \left(\frac{1-\$_2-\$_3}{\$_4R_t^*+\$_5G_t^*} \right) = \frac{R_t^*+G_t^*}{*_t(R_t^*,G_t^*)} \quad .$$

The long-run discount rate defined in equation (7.7) as $(1-\beta_2-\beta_3)/(\beta_4R^*_t+\beta_5G^*_t)$ can be obtained by setting $L^*_t = L^*_t = L_{t-2}$, and computed using the parameter estimates of equation (7.6); i.e.

$$(7.8)\quad *_t(R_t^*,\ G_t^*) = (1-1.467+.597)/(.0135R^{t*}+.0734G_t^*) = .13\ /\ (.0$$

In 1960 $G_t = 2.07$ and $R_t = 69.68$. Using (7.4) and (7.5) $R^*_{1961} = 76.026$, and $G^*_{1961} = 3.843$. Hence $\delta_{1961} = 9.94\%$. Likewise in 1993 $G_{1993} = 29.28$ and $R_{1993} = 44.38$, so the discount rate for 1994 with $G^*_{1994} = 54.64$ and $R^*_{1994} = 39.55$, implies $\delta_{1994} = 2.869$.

The derivatives of the discount rate (7.8) with respect to R^*_t and G^*_t are

$$(7.9)\quad \partial*(\bullet)\ /\ \partial R_t^* = -.00176\ /\ (.0135R_t^* + .0734G_t^*)^2\ ,$$

$$(7.10)\quad \partial*_t\ (\bullet)\ /\ \partial G_t^* = -.00954\ /\ (.0135R_t^* + .0734G_t^*)^2\ ,$$

both of which are less than zero. Hence, an increase in R^*_t and/or G^*_t will give rise to a decrease in the discount rate which increases land prices. Furthermore the rate at which $\delta_t(\bullet)$ changes with respect to G^*_t and R^*_t is positive, i.e. $\partial^2\delta(\bullet)/\partial R^{*2}_t > 0$, $\partial^2\delta(\bullet)/\partial G^{*2}_t > 0$ and $\partial^2\delta(\bullet)/\partial G^*_t\partial R^*_t = \partial^2\delta(\bullet)/\partial R^*_t\partial G^*_t > 0$.
The marginal response for G^*_t is greater than R^*_t. In 1961 $\partial\delta(\bullet)/\partial R^*_{1961} = -.001$ and $\partial\delta(\bullet)/\partial G^*_{1961} = -.006$ and in 1994, $\partial\delta(\bullet)/\partial R^*_{1994} = -.0002$ and $\partial\delta(\bullet)/\partial G^*_{1994} = -.001$. These results imply that a dollar of expected government payments is capitalized at a greater rate than a dollar of expected income earned from farm production. This may be due to the fact that government payments are more predictable and/or stable than production income which may, from a public policy perspective, reflect successful stabilization policy in transferring benefits to farmers.

The derivatives of the steady state land price with respect to R^*_t and G^*_t are given by

$$(7.11)\quad \partial L_t^*/\partial R_t^* = (2\$_4R_t^* + (\$_4+\$_5)G_t^*)\ /\ (1-\$_2-\$_3) = .207R_t^* + .668G_t^*\ ,$$

and,

$$(7.12)\quad \partial L_t^*/\partial G_t^* = ((\$_4+\$_5)R_t^*+\$_tG_t^*)\ /\ (1-\$_2-\$_3) = .668R_t^* + 1.129G_t^*\ .$$

and the second derivatives imply $\partial^2L^*_t/\partial R^{*2}_t > 0$, $\partial^2L^*_t/\partial G^{*2}_t > 0$, and $\partial^2L^*_t/\partial G^*_t\partial R^*_t = \partial^2L^*_t/\partial R^*_t\partial G^*_t > 0$.

The derivative for $\partial L^*/\partial R^* = 18.38$ in 1961 and 44.77 in 1994, while $\partial L^*/\partial G^* = 55.15$ in 1961, and 88.15 in 1994. The results reflect the change (increase) in long run, steady state land prices in

Ontario if R^* and G^* were held constant, and land prices are allowed to adjust. They show that land prices are more responsive to government subsidies than ordinary income.

7.6.2 Saskatchewan:

The same model was run for Saskatchewan using a similarly defined data set as Ontario. The results are presented below.

$$(7.13) \quad R_t^* = 1.380 + .917R_{t-1} + e_1 \qquad R^2 = .80$$
$$= (.64) \quad (11.3)$$

$$(7.14) \quad G_t^* = .761 + .905G_{t-1} + e_2 \qquad R^2 = .81$$
$$= (1.30) \quad (11.59)$$

$$(7.15) \quad L_t^* = 8.799 + 1.607L_{t-1} - .694L_{t-2} + (.0102R_t^* + .0637G_t^*)\ (R_t^*+G_t^*) + e_3 \quad R^2 = .97$$
$$= (.85) \quad (10.9) \quad (-4.65) \quad (1.42) \quad (1.67)$$

As with the Ontario model, all 3 equations work well, with 80% of revenue expectation being explained by its lagged value, 81% of government payments explained by its lagged value, and 97% of land values explained by lagged land values, revenue expectations and government payment expectations.

The time varying discount rate is given by

$$(7.16) \quad *_t(R_t^*, G_t^*) = (1-1.607 + .694) \,/\, (.0102R_t^* + .0637G_t^*)$$
$$= .087 \,/\, (.0102R_t^* + .0637G_t^*)$$

In 1960 $G_{1960} = 3.02$ and $R_{1960} = 19.64$, and in 1993 $G_{1993} = 10.70$ and $R_{1993} = 5.21$. Substituting these values into (7.13) and (7.14) and substituting for R_t^* and G_t^* in Equation (7.16) yields the time dependent long run discount rates, of 20.7% in 1961 and 11.95% in 1994.

In contrast, predicted long run capitalization rates in Ontario were shown to be 9.94% in 1961 and 2.87% in 1994.

The change in these discount rates over time depend on farmers expectations regarding future cash flows. For Saskatchewan

$$(7.17)\quad \partial^*(\cdot) / \partial R_t^* = -.00089 / (.0102 R_t^* + .0637 G_t^*)^2$$

$$(7.18)\quad \partial^*(\cdot) / \partial G_t^* = -.00555 / (.0102 R_t^* + .0637 G_t^*)^2$$

Using $R_{1961}^* = 19.38$ and $G_{1961}^* = 3.49$, and $R_{1994}^* = 6.16$ and $G_{1994}^* = 10.45$, the derivatives implied by (7.17) and (7.18) are

$$\partial^* / \partial R_{1961}^* = .005\ ;$$

$$\partial^* / \partial G_{1961}^* = -.0315\ ;$$

$$\partial^* / \partial R_{1994}^* = -.0017\ ,$$

and,

$$\partial^* / \partial G_{1994}^* = -.0105\ .$$

These numbers are revealing! Because land prices increase as the rate of capitalization decreases the results imply that land prices are more responsive to expectations in government payments than income from production. In other words a dollar increase in expected subsidies will have a greater impact on long run land price changes. The opposite also holds! A decrease in direct transfers to Saskatchewan farmers will have a larger increase in land price decreases than a drop in anticipated revenues from production.

In contrast to Ontario, it appears that Saskatchewan land values are much more susceptible to income and subsidy variability. For example using 1994 changes in the time varying discount rates the response in Ontario is only -.0002 for $\partial\delta/\partial R_{1994}^*$ versus -.0017 in Saskatchewan, and -.001 versus -.0105 for $\partial\delta/\partial G^*$ in Ontario and Saskatchewan, respectively.

The rationale for this probably lies in the relative riskiness of agriculture in the two provinces. Ontario's agricultural economy has been relatively stable and diversified with farm programs which are modestly consistent. Saskatchewan on the other hand is subject to substantially higher risks both in terms of production and yield, and in having to face volatile international markets. Consequently

Saskatchewan farmers are likely to react more swiftly to changes in programs and economic conditions than Ontario farmers.

The change in long run land values with respect to R^* and G^* is given by

$$(7.19) \quad \partial L_t^* / \partial R^* = .234R^* + .849G^*$$

and

$$(7.20) \quad \partial L^* / \partial G^* = .849R^* + 1.464R^* .$$

Using expectations for 1961 and 1994 the derivatives are \$7.51/acre for $\partial L_t^*/\partial R_{1961}^*$ and $\partial L_t^*/\partial G_{1961}^*$, respectively, and equivinately for 1994 \$10.37/acre and \$20.53/acre. These derivatives suggest again that government subsidies are capitalized into land values at a greater rate than production income.

These results are somewhat in conflict with the cointegration analysis of the previous section. In the cointegration analysis for Saskatchewan farmers did not perceive government income as being different from production income. However, it should be noted that the estimated coefficients in the land price equation are not statistically significantly different from zero at conventional 95% levels, but are at 90%. In this regards the two analyses are consistent.

7.7. Short Run Land Values:

While in the context of the Deloitte and Touche model general equilibrium results imply examining long run relationships, it is also useful to examine the impact of government programs on short run land values. In general,

$$\partial L_t / \partial R_t^* = \$_4 R_t^* + (\$_4 + \$_5) G_t^*$$

and

$$\partial L_t / \partial G_t^* = (\$_4 + \$_5) G_t^* + \$_5 G_t^*$$

These short term values differ from long run values by a factor of $(1-\beta_2-\beta_3)$, which equals .13 for Ontario and .087 for Saskatchewan. Assuming R_{1961}^* and G_{1961}^* the short run adjustment in land values with respect of a dollar of government subsidy is $7.17/acre in Ontario and $1.87 in Saskatchewan. Equivalent increases for 1994 are expected to be $11.46/acre in Ontario and $1.79 in Saskatchewan. The results again show that the response to government programs is much stronger in Ontario than Saskatchewan, a result which is consistent with the cointegration results and error correction models.

7.8. Discussion with Respect to Prediction:

Figure 7.3 presents the actual versus predicted values of land prices from the structural model for Ontario and Saskatchewan. The structural model follows and predicts the actual land values with substantial accuracy and tends to capture key turning points.

Figure 7.4 illustrates the relationship between long and short run land values. Short run land values are obtained directly from the predicting equations. Long run land values represent equilibrium land values and arise from a situation in which $R_t^* = R_{t+1}^*$, $G_t^* = G_{t+1}^*$, and $L_t^* = L_{t+1}^*$. That is, for long run equilibrium to occur, short run expectations must be persistent and consistent over time. If R_t^* or G_t^* do not change over time then ultimately L_t^* will come to equal L_{t+1}^* in equilibrium.

In reality R_t^* and G_t^* are neither persistent or consistent since they are revised periodically to changing economic conditions. Hence, not only the cash flows but the time-varying discount rate affects long run equilibrium values. As short run expectations and discount rates change, so do long run land values.

If long run discount rates exceed short run discount rates this implies that economic pressures are forcing land prices to increase. In Ontario the period 1960 through 1975 showed upward pressure in land prices and the tendency was for short run land values to increase. In 1975-1976 long run values decreased and the rate at which short run values increased began to slow. In 1981 land prices began to decline. Throughout the 1980's long run land values fell below short run values and the tendency was for land values to decrease. This was reversed in the late 1980's and land values again began to increase.

Land values in Saskatchewan show persistent short run over valuation relative to long run values with the latter lying below the former over most of this period. The economic situation in Saskatchewan, low returns and high risk, would explain this phenomenon. Part of the reason that short term land values exceeded their long run values could be due to income transfers from farm programs. Under this interpretation while economic conditions put downward pressure on land values, government programs and income transfers would dampen, or slow its decline. For example significant aggregate, and per acre, ad hoc transfers to Saskatchewan in 1988 and 1989 caused long term land values to increase and slowed the rate at which short run values decreased. The effects of ad hoc programs did not, as expected, lead to a persistent and sustained increase in land values.

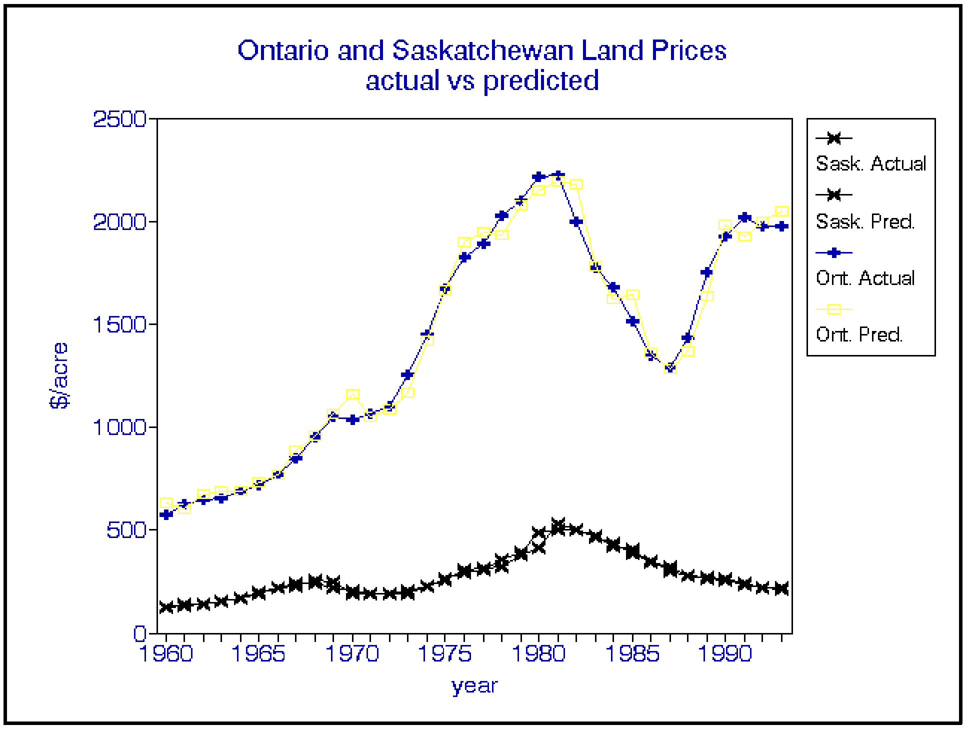

Figure 7.3: Actual vs Predicted Values of Land Prices: Ontario and Saskatchewan

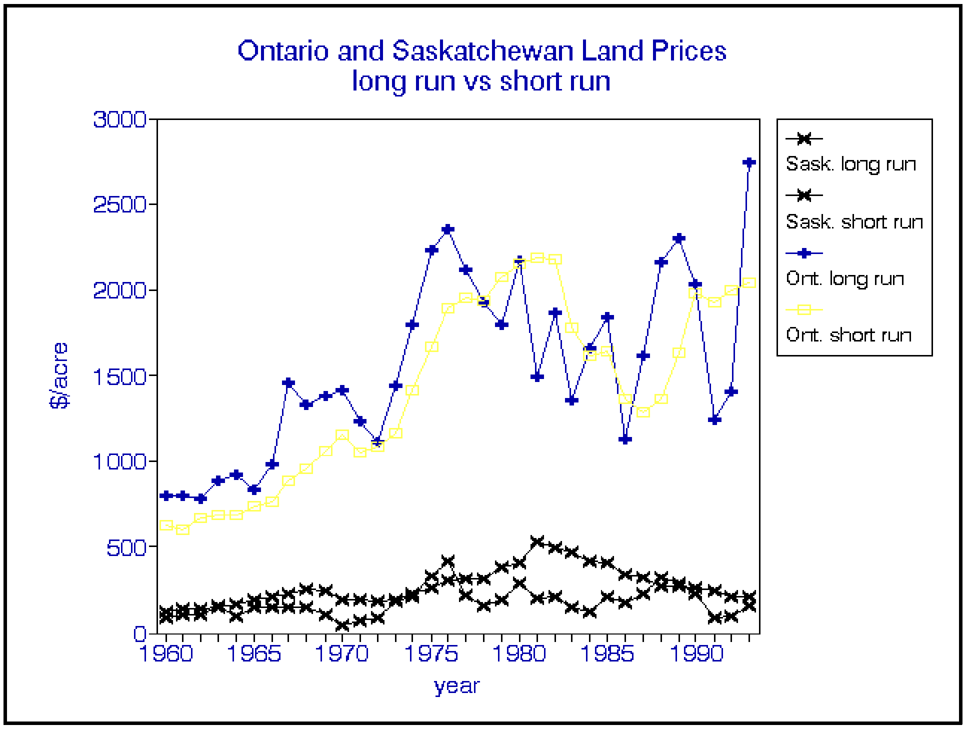

Figure 7.4: The Relationship between Long-Run and Short-Run Land Values

7.9. Time-Varying Discount Rates and Land Price Elasticities

Figure 7.5 compares the time-varying discount rates for Saskatchewan and Ontario. Throughout the 1960 to 1993 period discount rates in Saskatchewan were always higher than in Ontario. Much of this is due to risk. Ontario's agricultural economy is much more diversified than Saskatchewan's, so diversifiable business risks are lower in Ontario than in Saskatchewan. Given the economic differences in business risk it is not surprising that capitalization rates in Ontario would be lower. Also of interest is the relationship between government programs and production income. In Saskatchewan the substantial contribution that income transfer programs made to cash flows caused the discount rate to decrease, which confirms the hypothesis that increased government transfers decreases the risk premium. Throughout the 1960's and 1970's, government transfers increased in real terms relative to income from farming. In Ontario, where government transfers have made up a lower proportion of farm cash income the decrease in the discount rate is lower and the discount rate is relatively more stable.

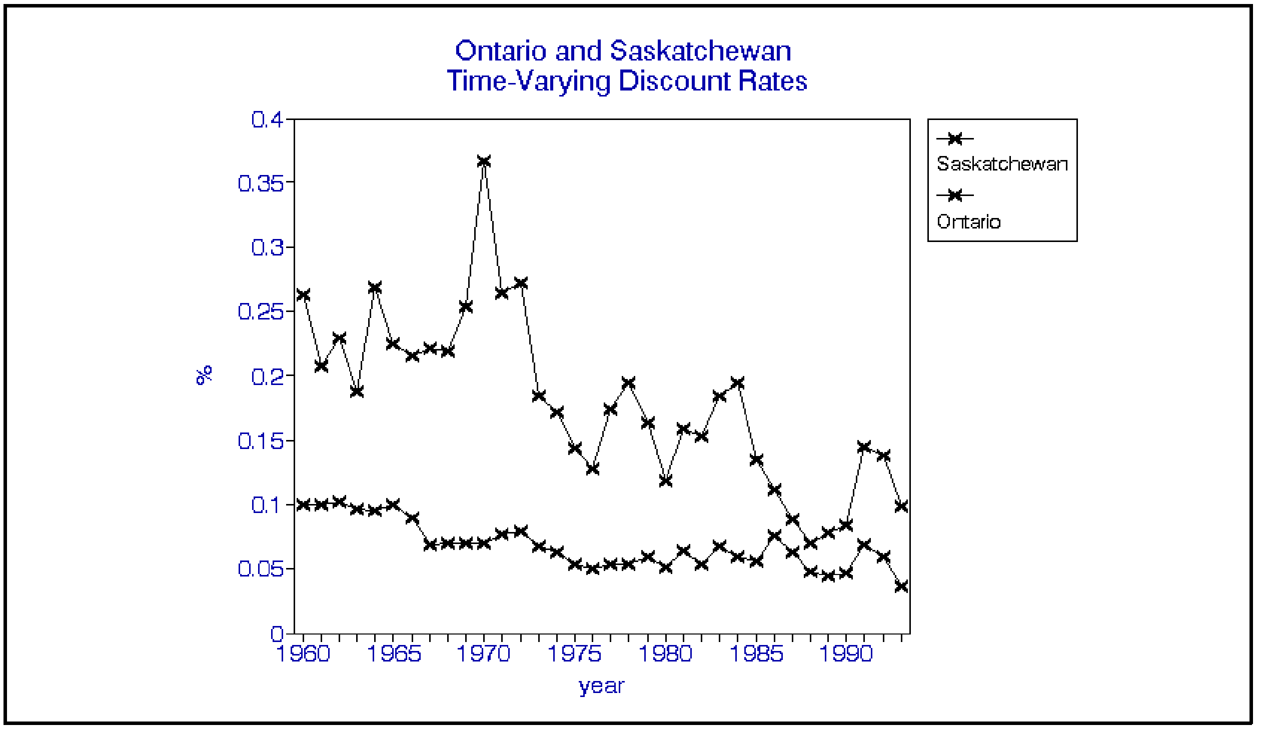

Figure 7.5:Time Varying Discount Rates for Ontario and Saskatchewan

The notion that capitalization rates respond to government programs is strongly supported for Ontario but less so for Saskatchewan. The cointegration analysis and error correction model in the previous section was devised to substantiate this hypothesis. The econometric and statistical properties indicate that farmers' response to subsidies and cash income from production are not consistent across provinces, with subsidies having less of an impact in Saskatchewan. This does not mean that Saskatchewan farmers exclude government transfers in pricing of land, but rather it implies that they do not differentiate a dollar of income transfer from a dollar of production revenue. In ontario not only do farmers capitalize cash income from all sources, but appear to view production income differently from income transfers. The difference in economic adjustment to income transfers between the two provinces may be attributable to the significant proportion of transfers in Saskatchewan which were ad hoc in nature, and hence unreliable as a source of cash or a means to reduce risk in the long run. As can be seen in Table 4.3 the variability in net transfers over the period 1989 to 1993 is much lower in Ontario than in Saskatchewan.

Table 7.8 compares the discount rates and land price elasticities for both the long-run (cointegration) model and the estimated structural model. Both models indicate that capitalization rates in Saskatchewan are higher than those in Ontario. From the long run model the discount rate is estimated to be 13.5% whereas the structural model has on average time-varying discount rate of 18%. Ontario results show discount rates of 8.7% and 7% for the long run model and structural model, respectively.

Table 7.8 also compares land price elasticities. In both models the elasticity of production income is more elastic than subsidy income or income transfers. The structural model implies that a 1% increase in government payments will increase long run land values by .51% in Saskatchewan and .61% in Ontario. These are more inelastic than the response to production income. For the structural model an 1% increase in production income would lend to a 1.25% increase in land values in Saskatchewan, and a 1.67% decrease in Ontario. The absolute difference in the elasticities can be attributed to the relative proportion of income transfers to production income over the period examined (1960 to 1993). The only inconsistent relationship between the long run model and the structural model is for the elasticity of income which is inelastic at .90% for the long run model in Ontario. This inconsistency may be due to differences in the periods used in the two analyses which were 1947-1993 for the long run model and 1960-1993 for the structural model.

7.10. Short and Long Run Effects of Changes to Cash Income and Transfer Payments:

The effects of changes in land values from changes in subsidies and production income is shown in Table 7.9 , for changes in per acre cash flows of -$30, -$20, -$10, 0, $10, $20, and $30. The relevant range of subsidy is between -$20/acre and $20.00

Both short and long run effects are shown. In Saskatchewan a $10.00 decrease in land values will result in a decrease in land price from $213/acre (the 1993 land value) to $190/acre in the short run. The tendency in this scenario is for land prices in the long run to converge to zero. An increase in income transfers of $10/acre will lead to an increase to $236/acre in the short run and $481/acre in the long run. In contrast a $10 decrease in income from production causes land prices to decrease from $213/acre to $205/acre in the short run, and $116/acre in the long run.

Similar results are found for Ontario. The 1993 land value in Ontario was $1975/acre. A $10/acre decrease in income support will cause this to decrease to $1,884 in the short run and $1,275 in the long run. A $10/acre increase will cause land prices to increase to $2,066/acre in the short run and $2,675 in the long run. As with Saskatchewan the effect of an increase in production income is not as pronounced. A $10/acre decrease in production income will result in a decrease from $1,975 to $1,942 per acre in the short-run and $1,718 per acre in the long-run. A $10/acre increase will lead to an increase in land prices to $2,008/acre in the short run and $2,232/acre in the long run.

Table 7.8 : Long Term Capitalization Rates and Elasticities

	Long Run Model	Structural Model
	Saskatchewan	
Discount Rate	13.5%	18.0%
Subsidy Elasticity	.86	.51
Production Income Elasticity	1.67	1.25
	Ontario	
Discount Rate	8.7%	7.0%
Subsidy Elasticity	.73	.61
Production Income Elasticity	.91	1.67

7.11. Welfare Analysis of Capitalization of Income Transfers:

The economic significance of the sensitivities portrayed in Table 7.8 can be placed in the context of the general welfare paradigm. Illustrated in Figure 4.1. For example, the $/acre value of GRIP over the 1991-1993 period was approximately $8/acre in Ontario. If GRIP were to be eliminated, without a substitute program, the demand for land would shift to the left, and land prices would decrease. In Figure 7.6 the initial land price is $1,975. An $8/acre decrease in land prices will cause demand to shift to D1 and prices to fall to $1,902/acre in the short run, increasing consumer surplus, and decreasing producer surplus. In the long run demand shifts to D2 and land values will decrease to $1,415/acre.

The loss in producer surplus is not a real loss but rather a paper loss reflected more on a market valued balance sheet than an income statement. None-the-less decreased asset values can impact farmer's ability to borrow. From the consumer's perspective, who in this case are future land owners, the decreased value of land improves accessibility, and barriers to entry are lowered.

A symmetrical argument also holds. If land was originally priced at $1,415/acre, an $8/acre GRIP payment would result in a capitalized value of $1,975/acre. In the long run the $560 increase represents a wealth gain for existing farmers and a barrier to entry to future farmers. It is important to note, however, that barriers to entry increase with time and the persistence of policy. In the short run, effects are modest, and the barriers to entry limited. Furthermore, new farmers buying land in the short run can still benefit from future income transfers and capital gains. In the long run these benefits are exhausted by the capitalization process.

A caveat to this type of analysis is the nature of the program's themselves. In reference to Table 4.3 the nature of program characteristics can impact on the degree of capitalization. The results of the structural model would be more accurate for commodity specific programs such as GRIP, NTSP, and crop insurance. NISA programs will unlikely impact land values in the short run (and hence the long run) because income transfers are placed in a specific account which is unaccessible for reinvestment in capital assets. Ad hoc programs such as disaster relief or drought assistance will impact land values but it is unlikely that long run impacts would be sustained. The reason for this is that ad hoc programs do not provide the reliable source of cash or risk reduction that some commodity specific programs might have. While the structural model will accurately predict a short run response to an increase in ad hoc payments, the long run effects would likely be overestimated somewhat.

Figure 7.6

Table 7.9: Changes in Saskatchewan and Ontario Land Prices in Response to Changes in Government Income Transfers and Production Income

Change in Cash ($/acres)	Short Run Subsidy Effect	Long Run Subsidy Effect	Short Run Income Effect	Long Run Income Effect
		Saskatchewan ($/acre)		
-30	142	0	188	0
-20	166	0	196	19
-10	190	0	205	116
0	213	213	213	213
10	236	481	221	310
20	260	748	230	407
30	283	1,016	238	505
		Ontario ($/acre)		
-30	1,702	0	1,875	1,204
-20	1,793	574	1,908	1,461
-10	1,884	1,275	1,942	1,718
0	1,975	1,975	1,975	1,975
10	2,066	2,675	2,008	2,232
20	2,157	3,376	2,042	2,489
30	2,248	4,076	2,075	2,746

Other programs, such as dairy subsidies or NTSP for cattle and hogs would also have less of an impact. CDC subsidies on milk would be reflected in quota values rather than land values, although some residual impact may occur. Similarly containment hog barns or beef feedlots receiving payments under NTSP would more likely impact on investment in buildings and technology than land. However, it is likely that a portion of these benefits would be capitalized into land values, if the programs were deemed to be persistent, reliable, and stable.

The structural model presented in this study can be used to predict the impact of changes in government support programs on land values. The results provide a means to estimate the potential impacts on the programs as well as providing support for the notion that government programs are capitalized into land (and other asset) values. Once more data becomes available it would be prudent to estimate the direct impacts of specific programs. However, data on specific programs is spurious, and the circumstances under which they were made differ from period to period. The estimated structural equation in this report only reflects an average response to income transfer programs.

8. SUPPLY MANAGEMENT AND QUOTA VALUES

The introduction of supply management to the Canadian dairy, tobacco, and poultry sectors has raised considerable debate about the distortionary impact that such programs have on the distribution of benefits to producer and consumers. The extent of economic distortion has been studied previously (Table 8.1), and the principal conclusion is that producers are the primary beneficiaries of supply control.

Table 8. 1: Economic Effects of Supply Management

Author and the Study Year	Commodity	Economic Gain	Producers Gain	Consumers Gain
		Millions of Dollars		
Barichello - 1980	Dairy	-214	955	-980
	Eggs	-19	55	-74
	Broiler	-13	57	-73
Arcus - 1979	Eggs	n.a.	45	-56
	Broiler	n.a.	71	-77
Veeman - 1979	Eggs	-0.4	38	-39
	Broiler	-5.0	71	-76
Harling and Thompson - 1975-77	Eggs	-5	74	-80
	Broiler	-11	94	-121

Source: Barichello (1982); Arcus (1981); Veeman (1982); Harling and Thompson (1983).

The most significant welfare loss is found in the dairy sector with eggs and broilers playing only a modest role although the price distortions in the egg and poultry sectors might be as large or larger (Committee of Experts). Although the welfare analysis is dated, the relative proportion of producer gains, and consumer and economic losses likely holds for 1995.

As summarized by Schmitz and Schmitz (1994) the following issues have been raised as arguments against supply management:

- Production costs increase disproportionately to changes in input prices.
- Quota regulations restrict the expansion and scale of operations.
- Producers earn economic rents at certain scales of production which would not ordinarily be earned without supply management.
- Average production is less than the minimum efficient size.
- Costs of carrying out and administering the supply management system are high.
- Higher cost structure for second generation producers due to significant quota values.

- Economic costs of inefficiencies caused by interprovincial trade and resource specialization may be significant.

Issues raised in favour of supply management are:

- Producer and consumer gains from price stability brought about by supply management.
- Gains in economic efficiency brought about by supply management.
- Bargaining influence over processors and retailers.
- Effects of import protection in the absence of supply management.
- Existence of distortions elsewhere in the economy.
- Artificially low import prices as a result of world wide subsidy programs.

Perhaps the most controversial aspect of supply management is the impact that pricing commodities above average and marginal costs has on the price of quota. This argument was first put forth by Forbes, Hughes, and Warley (1982) and has since been investigated by Moschini and Meilke (1988), Barichello (1994), and Beck, Hoskins, and Mumey (1994).

The capitalization effect of farm programs on quota values is of considerable concern. Specifically the extent by which economic rents, defined as the incremental cash benefits to holding quota, are capitalized into quota values can provide some evidence of distortionary economic impacts. First, the rate at which economic rents are capitalized into asset values is usually, under competitive conditions, measured by the firm's return on assets. Satisfying return on assets ensures that investment costs and returns are sufficient to ensure repayment of required returns to equity and debt.

When the capitalization rate is greater than the return on assets this is usually interpreted as an additional compensatory risk premium. This argument has been used by Moschini and Meilke (1988), Beck et al. (1994), and Barichello (1994).

If indeed the underlying cashflow structure is risky then the existence of a risk premium is legitimized by the standard economic logic, and the issue of quota capitalization and distortionary effects are mute. Alternatively, if the underlying cashflow structure is not uncertain, then capitalization rates above the expected return on assets is distortionary, and may lead to economic inefficiencies through adverse signalling and incentives.

8.1 Capitalization of Quota Values

Like land values, dairy (and other supply managed commodities) quota has value related to the incremental cash benefits to holding this quota. Quota sales are organized through formal exchanges where bids are placed and quota is awarded to the highest bidder.

While several quota capitalization models have been reported (Barichello (1982)) these relate quota prices to the implicit rental value measured by the differential prices in used and unused quotas.

In this view, the differential prices of the two types of quota reflect the rental value of quota for current delivery.

While the difference between used and unused quota prices has some bearing on the quota rental rate, it provides no evidence on how cash benefits are capitalized into quota prices. The critical factors affecting quota are similar to those affecting other capital investments, namely

1) incremental cash benefits obtained from quota;
2) holding period;
3) return on assets, or discount rate; and,
4) tax treatment.

Although farmers view quota with a 4-5 year payback, the value of quota would be priced over an almost infinite time horizon, so that the bid price for quota reflects the present value of future benefits. This is likely to hold over multiple holders of quota even with the current 15% assessment tax.

The difference between used quota and unused quota is that unused quota provides a benefit in the current dairy year, whereas used quota provides a benefit in the next quota year. The relationship between used and unused quota can thus be determined by:

$$(8.1) \qquad Q_{t+1} = e^{-rt}\, Q_t$$

where Q_{t+1} is used quota and Q_t is unused quota. The implicit short-run discount rate, or capitalization rate, r, is therefore:

$$(8.2) \qquad r = -\ln\left[\frac{Q_{t+1}}{Q_t}\right] t^{-1}$$

For example the price for Q_t (MSQ) in Ontario for July 1994 was \$38.00 kg., while Q_{t+1} was \$30.20/kg. Assuming t=1, r=22.9%. In January 1994 Q_t = \$24.00/kg and Q_{t+1} = \$20.00/kg yielding r=18.2%. If it is assumed that quota returns are valued on an after tax basis, and the average tax rate is 25% then the pretax January and July return on assets are 24.26% and 30.53% respectively; this is a high discount rate, but within the range discussed by Barichello, and Moschini and Meilke. It is, however, higher than the rates used by Beck, Hoskins, and Mumey.

In contrast, the return on assets for dairy farmers in 1993 is approximately 10% (net income before interest payments (\$47,917) divided by assets (\$480,477)) which is consistent with the long tern discount rate estimated from the cointegration relationship. This indicates that quota is discounted by a substantial risk premium of up to 20% in the short-run, perhaps due to uncertainty with regards to the future of Canadian dairy policy. Given this uncertainty, farmers are looking for sufficiently high returns to ensure a short (4-5 year) payback period. The requirement of such a short payback may be mitigated by the fact that lenders will provide credit for only 5 years, and that quota cannot be used to secure loans.

From an individual producer's perspective other factors such as capital gains tax and capital gains exemption come into play. However, it is unlikely that the capital gains exemption is relevant for many farmers, because it would be used up before the last unit of quota is sold. Thus, upon sale of quota the capital gains taxes would apply. Furthermore, upon sale of quota, (to non family members) the milk marketing board can claim as much as 15% of quota offered. Depending on the holding period used, these terminal impacts may have little bearing on today's quota price. However, they may have an impact on the supply of quota.

The bid price model in Baker, Ketchebaw, and Turvey can be used to determine quota prices. For simplicity it is assumed that quota is held for a sufficiently long period such that terminal effects are negligible. Their formula redefined for examining quota is

$$(8.3) \qquad Q_t = \frac{(P_m + S - C_m - C_o)(1-t)(1+g)/bf}{r(1-t)-g}$$

where Q_o = maximum bid price for quota ($/ha)
P_m = milk price
S = milk subsidy from CDC
C_m = milk marketing and advertising costs
C_o = incremental operating costs (feed, labour, etc.)
g = annual growth rate in net milk revenues
r = return on assets discount rate
bf = butterfat content (kg/hℓ)
t = average tax rate.

In 1993/1994 P_m-S-C_m = $50.48, from the 1994 Ontario Dairy Farm Accounting Project Annual Summary, and average cash operating costs are approximately $24.89/hℓ. Moschini and Meilke find that the average growth rate in milk revenue is 3%/year. Using the relationship between used and unused quota for November 1994, the implied pretax return on assets is 24.7%, and from ODFAP the average butterfat test is 3.97 kg/hℓ. Substituting these values into the bid price formula results in:

$$(8.4) \qquad Q = \frac{(50.48-24.89)\ (1-.25)\ (1.03)\ /\ 3.97}{(.247\ (1-.25)\ -.03)} = \$32.90/kg$$

which is close to the average quota price of $33.43 reported from January to November of 1994.

8.2. The Transfer Efficiency Effects of Capitalized Quota Values

The persistence of high capitalization rates for quota values have not received enough attention in quota capitalization research. Moschini and Meilke report high capitalization rates for the 1980's; although the interest rates (both in nominal and real terms) were high during this period, there was no immediate threat of dismantling supply management under GATT or NAFTA. High capitalization rates comparable to those reported by Moschini and Meilke have also been reported for more recent years. Since prices to farmers are based on a cost of production formula, profit margins have generally been maintained. Given this environment, where downside risk is negligible, arguments that high rates of return used to capitalize quota are due to a risk premium, may not be the only explanation.

Part of the disparity may be explained through the institutional lending structure which prohibits quota use as security, and rarely provides loans for quota purchases of greater than 5 years duration. This institutional structure requires all loans to be self liquidating and requires a payback period of at most 5 years. In order for this to occur farmers must capitalize quota at a higher rate than would ordinarily be used to discount future cashflows. To put this in perspective, if dairy farmers did not require such a high payback, and could spread the cost of investment over a longer time period, the value of quota would be in excess of $70/kg b.f. This is shown by the following formula, which is identical to the previous one except the actual after tax reinvestment rate (ROA) is only 10% (13% pre-tax).

$$(8.5) \qquad Q = \frac{(50.48-24.89)\,(1-.25)\,(1.03)\;/\;3.97}{(.13(1-.25)\;-\;.03)} = \$73.77$$

The difference between $73.77 - $32.9 = $41.38/kg. b.f. represents the present value contribution to wealth for holding 1 kg. of quota. The spread will be larger for farmers whose marginal costs of production are lower than $24.89/hℓ or have a required return on assets less than 13%, or have milk with less than 3.97 kg/hℓ butterfat.

8.3. Quota as a Barrier to Entry:

Quota is viewed as being a barrier to entry at the industry level, because the total quota allotment is fixed to match domestic supply and demand. This has been argued to create quasi monopoly powers for the industry which extracts economic rents from processors, retailers, and consumers.

The impact of capitalization has also been argued to create barriers to entry for new farmers. To examine the impact on beginning farmers we can increase the costs to reflect the cost structure of a beginning farmer. The 1994 Ontario Dairy Farm Accounting Project reports cash expenses of \$37.55/hℓ and \$5.42/hℓ for depreciation expense. On an after tax basis the total cash costs, including the depreciation tax shield, is \$26.82/hℓ. If this is used as the incremental cash costs associated with a unit of quota, then the quota value reduces to \$40.91/kg. The difference between this value and the market value of \$32.39 is only \$8.52/kg. b.f. Although the benefit is still positive it is about a quarter of the benefits enjoyed by the existing farmers. It is because of the relative magnitude of potential benefits, the existing producers will always be able to outcompete beginning farmers in the quota market.

8.4. Impact of Quota Capitalization on Other Asset Values

If quota is undervalued and contributes to the net wealth of (dairy) farmers, then it also provides a source of liquidity and debt servicing capacity. This suggests that dairy farmers may have an advantage over other farm types in their ability to bid higher for non-quota capital assets including land, building, technology, and breeding stock. As shown in the following table 8.2, dairy producers have a substantial asset base relative to other farm types, except beef feedlots. However, the degree by which dairy farmers are leveraged relative to swine and cash crop farmers is much lower. In 1993 Ontario dairy farmers had 74% equity whereas cash crop farmers had only 62% equity. Furthermore, the asset base for beef feedlots and cow calf operations as well as their equity position indicates that excess-over-quota profits are not capitalized into other assets.

Table 8.2: Asset Values, Percent Equity and Value of Production by Farm Types in Ontario: 1989-93.

	1989	1990	1991	1992	1993
Asset Values (000 $)					
Dairy	713,163	764,577	830,343	903,754	930,340
Beef Feedlot	821,431	783,651	752,478	709,444	919,952
Cow Calf	345,118	342,564	351,066	333,266	347,213
Swine Farrow	304,478	319,317	295,447	337,485	345,026
Swine Farrow to Finish	444,971	462,448	448,689	497,800	479,307
Swine Finishing	360,792	394,150	431,382	433,631	513,786
Cash Crop	419,021	331,139	314,689	332,570	336,630
Percent Equity					
Dairy	69	73	74	73	74
Beef Feedlot	72	75	76	77	86
Cow Calf	87	89	87	85	82
Swine Farrow	58	58	60	60	54
Swine Farrow to Finish	60	60	60	62	61
Swine Finishing	64	63	60	52	52
Cash Crop	59	60	59	66	62
Value of Farm Production (000 $)					
Dairy	168,168	169,916	183,009	192,382	190,269
Beef Feedlot	151,800	140,203	135,008	143,309	165,031
Cow Calf	43,928	42,817	42,809	51,235	52,042
Swine Farrow	68,711	95,181	87,058	98,975	113,346
Swine Farrow to Finish	128,256	139,467	138,504	156,859	158,226
Swine Finishing	106,151	105,376	124,773	131,334	120,436
Cash Crop	138,888	114,137	119,940	120,490	117,080

Source: Ontario Ministry of Agriculture, Food and Rural Affairs, 1993.

8.5. Impact of Quota Capitalization on Cost Efficient Production

It has been argued that supply management leads to an inefficient level of production and a failure to capture scale economies. Table 8.3 is taken from Schmitz and Schmitz (1994) and is based on a 1992 cost of production study by Jeffrey.

Table 8.3: Costs of Producing Milk in Canada and in the U.S., 1992.

Province or Satate	Production Costs (Cdn. $) per hectolitre			
	Labour Costs	Feed Costs	Variable Costs	Total Costs
Quebec	13.70	18.10	26.20	42.20
Ontario	13.00	21.70	33.00	45.30
Manitoba	13.30	16.80	25.80	40.70
Saskatchewan	n.a.	18.50	30.40	48.60
Alberta	11.70	15.90	25.20	37.40
British Columbia	n.a.	12.90	26.60	47.60
New York	8.20	21.20	22.70	37.10
Minnesota	9.40	17.40	24.00	31.80
Washington	3.90	14.50	25.00	35.10
California	3.70	16.30	24.60	29.30

Source: Schmitz and Schmitz (1994)

The results of this study show that costs of production are on average $43.63/hℓ in Canada and $33.33 in the U.S. for a $10.00/hℓ difference. Over half of this difference can be explained through differential labour costs which are $12.95/hℓ in Canada and only $6.30 in the U.S. When labour charges, much of which is imputed, is excluded from the cost calculation, the average cost differential in Canada is only about $3.65/hℓ.

If cash costs could be reduced by $3.65/hℓ, in Canada, quota prices (under the base assumption of $32.39/kg b.f.), prices would increase to $36.65/kg, or an increase of only 13%. It does not appear that to the extent that cost inefficiencies exist, they are protected by the quota system. In fact, the opposite is more likely to be true; if quota capitalization rates are in excess of operating return on assets, there is every incentive under a quota system to produce as efficiently as possible. And yet our average scale of operation is small (<50 cows) compared with New York. Also, most studies suggest economies of size up to at least 100 cows.

8.6. Welfare Impact of Quota Capitalization:

The long run cointegration analysis on quota prices indicated that the long run discount rate is approximately 8.1%. In the short run discount rates range from approximately 20% to 30%. Figure 8.1 shows the welfare effects in the short and long run. Because of the high short term capitalization effects marginal costs increase from MC0 to MC1 with the area bco being transferred from new owners of quota to existing owners of quota (and to the milk board). In the long run marginal costs increase to MC2 with the area aco being transferred to existing owners. At point a in Figure 8.1 marginal revenues equal marginal cost so no further capitalization can take place without incurring losses.

With a perfectly inelastic supply of quota, and downward sloping demands the effects of increased benefits to supply management is reflected in outward shifts to the demand curves while reduced benefits are reflected by shifts to the left. In Figure 8.2 it is assumed that the original quota price ($/kg b.f.) equals $32.90. If the subsidy on milk is reduced by $3/hℓ then short run quota prices would fall by $3.76/kg b.f. (assuming milk is 3.9kg b.f./hℓ) to $29.14 with a 25% discount rate. In the long run the $3/hℓ decrease in subsidy will result in a final quota price of about $19.92/kg using a 10% discount rate.

The economics of quota price capitalization parallels that of land prices. Changes to subsidies or quota policies which increase economic (cash) benefits to farmers results in increased quota prices which creates a modest barrier to entry in the short run and a significant barrier to entry in the long run. The beneficiaries of such programs are existing holders of quota. If subsidies decline, wealth accumulation to existing holders of quota diminishes modestly in the short run, and substantially in the long run. The beneficiaries of a decline in program benefits are new entrants into dairy farming.

Figure 8.1

Figure 8.2

9. LINKAGE TO THE DELOITTE & TOUCHE MODEL

This section provides the link between the results of this study and the structural model found in Deloitte and Touche Annex A. The intention here is to develop a model consistent with theirs, which will allow for the economic impacts of capitalization to be measured.

For purposes of consistency only the first 3 equations in D-T need to be considered. These 3 equations from their hog model are

$$(9.1) \quad Q_h = G a^{\alpha} b^{\beta} \qquad 0 < \alpha, \beta < 1$$

$$(9.2) \quad P_a = (P_h + S)\, \alpha G a^{\alpha - 1} b^{\beta}$$

$$(9.3) \quad P_b = (P_h + S)\, \beta G a^{\alpha} b^{\beta - 1}$$

The first equation is the industry production function with output quantity Q_h ,

G = the technological coefficient for hogs (in Canada)
a = is the amount of farm supplied inputs in Canada for hog production
b = the amount of purchased farm inputs in Canada for hog production
α = the production elasticity of farmer owned inputs
β = the production elasticity of farmer purchased inputs
P_a= the price of farmer owned inputs in Canada
P_b= the price of purchased inputs in Canada
S = the net payments through various government programs.

To fit the synthetic model outlined in the Deloitte-Touche Annex, the price of land, in the long run, is specified (see equation 3.4 in section three of this report for details) as,

$$(9.4) \quad P_a = \frac{(\alpha_4 YS + \alpha_5 Y(P - P_b))\,(Y(P + S - P_b))}{(1 - \alpha_1 - \alpha_2)}$$

or

$$(9.5) \quad P_a = \frac{Y^2(\alpha_4 S + \alpha_5(P-P_b))\,(P+S-P_b)}{(1-\alpha_1-\alpha_2)}$$

where Y = Q/a is the production per acre or hectare of land, and P_b is the average cost of purchased inputs per unit of output. The assumption of P_b being based on a per-unit-of-output basis is a simplification geared towards making the model more tractable. Normalizing Q (the dependent variable in Equation (9.1)) assures that the \$/acre unit measure of P_a is satisfied.

Using (9.5) as the definition for P_a, it is necessary to further differentiate it with respect to a, and b. This is required to satisfy the first order conditions of the profit maximizing problem and results from the fact that Y in Equation (9.6) is a function of a and b. Consequently,

$$(9.6) \quad \partial P_a/\partial a = -\frac{2Y^2}{a}\;\frac{(1-\alpha)\,(\alpha_4 S+\alpha_5(P-P_b))\,(P+S-P_b)}{(1-\alpha_1-\alpha_2)} < 0$$

$$(9.7) \quad \partial P_a/\partial b = \frac{2\beta Y^2}{b}\;\frac{(\alpha_4 S+\alpha_5(P-P_b))\,(P+S-P_b)}{(1-\alpha_1-\alpha_2)} > 0$$

Equation (9.6) simply reflects the own price effect of farmer owned assets (land) and should be considered if the supply of land is not perfectly inelastic. However, much of the research on land capitalization models or land pricing models assume that the supply of land is very inelastic, if not perfectly inelastic. If a perfectly inelastic supply function is assumed then the derivative $\partial P_a/\partial a$ would not exist.

Similarly, the changes in the price of purchased inputs, P_b, with respect to inputs a and b are given respectively by the following two equations:

$$(9.8) \quad \partial P_b/\partial a = (P+S-P_b).\alpha\beta\frac{Q}{ab} > 0$$

and,

$$(9.9) \quad \partial P_b/\partial b = (P+S-P_b)\beta(\beta-1)\frac{Q}{b^2} < 0$$

These are standard and theoretically consistent results. Empirically, however, the primal equations need to be solved simultaneously.

Finally, the effect of direct government subsidies on farmland prices can be determined by differentiating equation (9.5) with respect to S. Thus,

$$(9.10) \qquad \frac{\partial P_a}{\partial S} = \frac{Y^2[(\text{"}_4(P+S-P_b) + (\text{"}_4 S+\text{"}_5(P-P_b))]}{(1-\text{"}_1-\text{"}_2)} > 0$$

which shows that the overall impact of direct government subsidies (in the form of price support) is to increase the price of farmland.

10. SUMMARY AND CONCLUSIONS

The overall objective of this research was to investigate the direct and indirect impacts that capitalization of government program benefits have on primary agricultural production. These effects may provide incremental benefits which are not accounted for in the direct dollar measures of transfer efficiencies. Specific objectives and how those objectives were reached are discussed below.

Objective 1: *Provide an analytical approach to determine how various forms of government programs are capitalized into the value of farm assets.*

This research developed an adaptive expectations model of land prices which predicts land values as a function of land lagged twice, and expectations about revenues from farm income and revenues from government transfer payments. A theoretical aspect of the model development included a time varying discount rate. A time-varying discount rate allows changes in expectations to be reflected in the rate at which cash is reinvested.

The notion of a time varying discount rate was validated using time series cointegration and error correction models for Ontario, but not so strongly for Saskatchewan. Furthermore, the results for Saskatchewan did not strongly support the notion that farmers view government transfers and income from production differently when they make land capitalization decisions. However, the results for Ontario support this notion.

The structural econometric model showed that average time-varying discount rates were higher in Saskatchewan than Ontario. Part of this is due to the level of income transfers in Ontario which are substantially higher on a per acre basis than those in Saskatchewan. In general, the elasticities of land prices with respect to government transfers are inelastic whereas land prices are quite elastic with respect to production income. Much of the difference in elasticities can be explained by the relative magnitudes of production income to government transfers.

Objective 2: *Extend the theoretical framework developed in the Deloitte and Touche report to include the potential impact of capitalization*

The research developed a model which could be used to predict long and short run responses to government programs. The long run model was integrated with the Deloitte and Touche partial equilibrium model of the agricultural economy

Objectives 3 and 4: *Provide conditions or factors concerning program design and sectoral characteristics that may result in the capitalization of income transfers into farm assets and assess the implications regarding program capitalization for programs offered to supply managed, grain and oilseeds, and red meats sections*

The research presented in this report rests upon the proposition that land capitalization is affected by increased cash revenues and decreased risk. It follows that the degree of capitalization of transfer programs should be measured relative to these attributes.

Commodity specific programs such as GRIP or NTSP provide expected benefits which exceed farmer paid premiums by a substantial margin, as well as providing significant downside risk protection. In contrast, ad hoc programs while providing income support is not sufficiently reliable to reduce risk premiums, nor are payments sufficiently sustained or persistent to induce long term capitalization effects.

NISA and NISA-type programs have the characteristic that farmers make contributions to a savings account, matched to some extent by government, and earn above average interest rates. Because benefits are held in a savings account which can be used only in times of adversity, and not for reinvestment in assets, it is unlikely that NISA will have a significant impact on land prices.

A cursory examination of quota values was also provided. The public policy concern with quota is the substantial burden put on consumers and taxpayers relative to producers' benefits. Results indicates long run discount rates of less than 10%, and short term rates in excess of 20%. It is argued that there are institutional structures which require farmers to require a rapid payback on quota purchases. Part of this may be attributed to risk, but more than likely it is due to the fact that quota cannot be used as collateral for loans, and lenders are generally unwilling to provide funds for more than 7 years. It was concluded that these institutional restrictions inhibit the benefits of supply management for being fully capitalized into quota values in the short run. Evidence was presented using cointegration analysis that the long run discount rate for quota prices in Ontario is 8.1%.

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APPENDIX A: UNIT ROOT TESTS

A number of statistical tests have been proposed in the literature which can be used to test for the presence of unit roots or the degree of integration of individual series. The most popular among these tests is the Dickey-Fuller test (Dickey and Fuller 1979). The Dickey-Fuller statistic to test for the order of integration of the time series X_t is based on the following regression:

$$(A.1) \qquad X_t = A + "X_{t-1} + u_t$$

This can be reparameterized as follows:

$$(A.2) \qquad)X_t = A + ("-1)X_{t-1} + u_t$$

The null hypothesis that the series X_t contains a unit root can be tested either as Ho: α=1 or Ho: (α-1)=0. Note that the t-values of the coefficients do not follow a standard t-distribution. The critical values are derived through simulation and are reported in Fuller (1976) and in McKinnon (1991). If it is suspected that the series may also contain a deterministic trend, then the second equation can be expanded to include a trend variable. The Dickey-Fuller test is based on the assumption that the variable X_t follows a simple first-order autoregression and that the errors are identically, independently distributed normal variate. When these assumptions are approximately true, the Dickey-Fuller test is very powerful. In reality, however, economic time series are often characterized by serial correlation and the basic Dickey-Fuller test needs to be modified to account for the presence of serial correlation in the series. The modified Dickey-Fuller test is called the Augmented Dickey-Fuller (ADF) test. The modification involves the inclusion of lagged dependent variable in the regression such that:

$$(A.3) \qquad)X_t = A + ("-1)X_{t-1} + \sum_{i=1}^{n} (_i)X_{t-i} + u_t$$

Where the lag-length n is chosen to make sure that the residuals are white noise. As before, the t-value of (α-1) is used to test for the presence of a unit root in the series.

An alternative statistic to test for the presence of unit root has been suggested by Phillips and Perron (1988). While the DF and ADF statistics are based on the assumption that the error term is iid, the Phillips-Perron test allows for weak dependence and heterogeneity in the error term. Under such conditions a wide variety of Data Generating Processes for the error term can be allowed in the model. The Phillips-Perron test computes the DF statistic and then use some non-parametric adjustments to eliminate the effects of nuisance parameters on the limiting distribution of the test statistic. For the following regression model:

$$(A.4) \qquad)X_t = A + \$t + ("-1)X_{t-1} + u_t$$

with β=0, Phillips and Perron define,

$$(A.5) \qquad Z(\mathrm{J}_\mu) = (S/S_{Tm})\mathrm{J}_\mu - 0.5(S_{Tm}^2 - S^2)T[S_{Tm}^2 \sum_{2}^{T}(y_t - y^c)^2]^{-1/2}$$

Where T is the sample size and m is the number of estimated autocorrelations, $y^c=(T-1)^{-1}\Sigma y_{t-1}$, S^2 and τ_μ are, respectively, the sample variance of the residuals and t-statistic associated with (α-1) from the regression; S_{Tm}^2 is the long-run variance estimated as:

$$(A.6) \qquad S_{Tm}^2 = T^{-1}\sum_{t=1}^{T} e_t^2 + 2T^{-1}\sum_{s=1}^{l}\mathrm{T}_{sm}\sum_{t=s+1}^{T} e_t e_{t-s}$$

Where e's are the residuals from the regression. The triangular kernel ω_{sm} is used to ensure that the estimated long-run variance is positive definite (Newey and West, 1987).

When there is a deterministic trend in the model (i.e., β ≠ 0), the corresponding Phillips-Perron Statistic is given by,

$$(A.7) \qquad Z(\mathrm{J}_\mathrm{J}) = (S/S_{Tm})\mathrm{J}_\mathrm{J} - (S_{Tm}^2 - S^2)T^3[4S_{Tm}(3D_{xx})^{1/2}]^{-1}$$

Where S and S_{Tm} are defined as above, and D_{xx} is the determinant of the regressor cross-product matrix. The Phillips-Perron test also do not follow any standard limiting distribution and so, the critical values are derived from Monte Carlo Experiments.

APPENDIX B: ESTIMATING THE LAND CAPITALIZATION EQUATIONS

There are two basic approaches to the estimation of models that are characterized by unit root non-stationarity. The first is the two step estimation procedure introduced by Engle and Granger (1987). In this approach, the long-run or steady state parameters are estimated in the first stage. This is called the cointegrating relationship in the literature. The cointegrating regression can be used to estimate the deviations from long run equilibrium that are needed in the second stage to estimate the error correction model. These deviations from long-run equilibrium are the error terms of the cointegrating relationship. In the second stage, the short-run dynamics of the model are estimated from a vector autoregression (VAR). In the second approach, the short-run and long-run parameters are estimated jointly.

For this study, the two stage estimation procedure is used. This estimation strategy is taken for two reasons. First, as Campbell and Shiller (1987) have shown, the capitalization model that is studied in this report can be manipulated to identify the short-run and long-run parameters. This means that the two are easily interpreted. Second, Park and Ogaki (1991) have presented some Monte Carlo evidence that suggests that the two stage estimation procedure has good statistical properties.

One problem with the two step procedure is the choice of normalization. In the cointegration literature the choice of regressand (dependent variable) and regressors (independent variables) is arbitrary. This means that there may be more than one long-run equilibrium relationship that may exist among variables. For this study, all three of land price per acre, income per acre and subsidies per acre are used as regressands. In each case another potential equilibrium (or cointegrating) relationship is being identified.

In this study, the canonical cointegrating regression (CCR) is used to estimate the parameters of the cointegrating relationship. This estimator is a two step estimator. In the first step, OLS is applied to the estimating equation. Let the errors from the OLS regression be $\{v_t\}$. Also let ΔZ_to be the vector of variables associated with the regressors of estimating equation (i.e. they would not include an intercept) that are assumed to contain a unit root. Let the vector $w_t = (v_t, \Delta Z_t\text{o}')'$. Define the matrices

$$(B.1) \qquad 7 = \frac{1}{T}\sum_{s=1}^{T} \mathrm{T}(s) \sum_{t=s+1}^{T} w_t' w_{t-s}$$

$$(B.2) \qquad \mathrm{G} = \frac{1}{T}\sum w_t' w_t$$

$$(B.3) \qquad ' = G + 7$$

and

$$(B.4) \qquad S = G + 7 + 7^{/}$$

where T is the sample size and ω(.) is a spectral weighting scheme. Although there are several weighting schemes that can be used, in this report, we use the quadratic kernel and its associated bandwidth parameter. This bandwidth parameter is a data dependent plug-in estimate of an optimal value determined by Andrews (1991). We also prewhiten the residuals by a first order autoregressive scheme and then recolour the estimates as suggested by Andrews and Monahan (1992) for heteroscedastic and autocorrelation consistent estimators of the kind considered in this paper.[7] The matrices defined above can be partitioned into

$$(B.5) \qquad S = \begin{vmatrix} S_{uu} & S_{uz} \\ S_{zu} & S_{zz} \end{vmatrix}, \quad 7 = \begin{vmatrix} 7_{uu} & 7_{uz} \\ 7_{zu} & 7_{zz} \end{vmatrix}, \quad ' = \begin{vmatrix} '_{uu} & '_{uz} \\ '_{zu} & '_{zz} \end{vmatrix}$$

and further define

$$(B.6) \qquad '_{2} = \begin{vmatrix} '_{uz} \\ '_{zz} \end{vmatrix}$$

Since Z_t contains unit roots and Z_t and Y_t are cointegrated, special transformations of these variables needs to be undertaken to rid the estimates of nuisance parameters. The canonical cointegrating regression transformations that do this asymptotically are given by

$$(B.7) \qquad Y_t^{*} = Y_t - (G^{-1}{'}_2 b_2 + (0, S_{uz}S_{zz}^{-1})^{/})^{/} w_t$$

[7] Andrews and Monahan (1992) also argue the eigenvalues of the first order autoregressive scheme used to prewhiten the residuals that are close to one show be replace by a more stable estimate (see their footnote 4). This suggestion is also followed in this research.

and

$$(B.8) \qquad Z_t^* = Z_t - (G^{-1}{}'_2)' w_t$$

where b_2 is the OLS estimate of the parameters associated with the Z_t vector of unit root regressors. The CCR estimator of the parameters is given by the OLS estimates of the model

$$(B.9) \qquad Y_t^* = *_1 + Z_t^* *_2 + u_t^*$$

where δ_1 and δ_2 are parameters of the CCR estimator to be estimated and u_t* are the estimates of the residuals based upon the CCR estimator of the cointegrating relationship.

Park's (1990) J_1 variable addition test can be used to test for cointegration among variables using the CCR estimator. The J_1 variable addition test is based on the statistic

$$(B.10) \qquad J_1 = \frac{SSE^R - SSE^U}{S_{u.z}}$$

where SSE^U is the unrestricted residual sums of squares, SSE^R is the restricted residual sums of squares and $\Omega_{u.z} = \Omega_{uu} - \Omega_{uz}\Omega_{zz}^{-1}\Omega_{zu}$. SSE^U is typically derived by adding superfluous regressors to the CCR estimator and the SSE^R are derived from the residuals of the CCR. These superfluous regressors can be deterministic time trends and/or randomly generated I(1) processes. The critical feature is that a superfluous regressor be a non-stationary process. The statistic given by equation the J_1 test is asymptotically distributed as a $\chi^2(q)$ where q is the number of superfluous regressors included in the unrestricted regression. The null hypothesis is that there is cointegration among the variables; rejection of this test therefore implies no cointegrating relationship among the variables.

Park argued that, although the J_1 test is asymptotically invariant to the number of superfluous regressors included in the regression, for small samples, more superfluous regressors included in the tests should be better able to distinguish between competing alternatives than can fewer superfluous regressors (at least up to three). This observation suggests that the credibility of the J_1 test for a higher number of regressors should be higher than for a lower number. In the second stage, the (stationary) residuals u_t derived from the CCR estimator are used in conjunction with the first differences of the variables to estimate the error correction form of the model. Since the errors come from the cointegrating regression, they are stationary. Since all the variables are assumed to have a single unit root, first differencing them once will make them stationary. Since all the variables in the error correction form of the model are stationary, estimation of the short run dynamics of the system can now be achieved through traditional estimation techniques (for example, OLS).