Government support, transfer efficiency, and moral hazard within heterogeneous regions in Canadian Agriculture

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Abstract

This study estimates the transfer efficiency of government payments on Canadian agriculture. Three measures of efficiency are used: (1) the capitalization of support into farmland values, (2) the rate of income stabilization, and (3) the effect of past government support on the variance of income. We derive transfer efficiency estimates by applying panel econometric techniques to provincial time series data. With regard to the capitalization formula, we find that the capitalization of government into farmland values is homogeneous across provinces. We estimate the rate of capitalization at approximately $11.76 for every $1.00 increase in government support. A substantial amount of heterogeneity was found for the stabilization equation. Four homogeneous regions were found for Canada: 1) Maritimes; 2) Central Canada; 3) Western Canada; and 4) British Columbia. Among these heterogeneous regions, substantial differences in the stabilization coefficient estimates were found. There is also evidence of a trend in government payments in the Maritimes, indicating evidence of rent seeking. The variance of income was found to be correlated with past levels of government support, indicating that government support may be causing a moral hazard problem.

1. Introduction

Government support of agricultural producers is a cornerstone of agricultural policy in Canada and other countries of the developed world. Significant differences in the approaches used to support producers exist across regions exist. For example, the EU has largely decoupled agricultural through the use of direct payments schemes that are not dependent upon market prices, farm income, or production decisions (Rude, 2008; Sckokai and Moro, 2006). The US maintains price and revenue support based on production, as well as programs designed to stabilize income (Josling *et al.* 2007). For non-supplied managed industries, Canada has implemented a blanket approach to income stabilization that is not as commodity specific as US programs. In general, the amount of support given to Canadian producers is largely determined by changes in farm income.

Providing income support to producers is a cornerstone of agricultural policy in Canada, and is not a trivial matter for agricultural producers or policymakers (Skogstad, 2008; Schmitz, 2008). In recent years, the share of total farm income from government payments to producers in Canada has increased steadily, with unprecedented levels of support given after the BSE crisis. For example, in 2006 government payments accounted for approximately 84% of total net income in the agricultural sector (Statistics Canada, various). Approximately half of government expenditure in the agricultural sector is program payments, where as substantially less is spent on other areas such as rural market development and environmental protection (AAFC, 2007). Although the recent shocks to the Canadian agricultural sector have generated an unusually large amount of government support, these events highlight the importance of government support to its agricultural producers.

The recent upward trend in direct payments may be at odds with some of the objectives of Canadian agricultural support policies. Policy objectives state for example that support program payments should minimize moral hazard, should not be capitalized into farmland values, and should not distort regional comparative advantage across provinces (AAFC, 2009a). In Canada, studies that have evaluated the transfer efficiency of agricultural support payments have largely been focused on estimating the impact of support on farmland values. Examples include studies by Clark *et al.* (1993) and Weersink *et al.* (1999) on the capitalization of government support into farmland values in Saskatchewan and Ontario, and the study by Weerahewa *et al*. (2008) which provides an estimate of the average capitalization rate across all provinces. Surprisingly, there appears to be a dearth of Canadian studies that evaluate other important efficiency measures such as the rate of income stabilization or moral hazard.

Given the recent increases in direct payments in Canada, studying the transfer efficiency of government support in relation to policy objectives is an important area of research. The objective of this paper is to estimate three measures of transfer efficiency that are of concern to policymakers. These are (1) the capitalization of support into farmland values, (2) the rate of income stabilization, and (3) the effect of past government support on the variance of income. The level of capitalization is an important policy question because farmland is the major source of wealth to the sector. Both the second and third objectives are of importance because they evaluate how government support impacts production risk. Finally, it is important to have disaggregated measures of transfer efficiency so that regional disparities associated with government policies can be examined to assess potential distortions in regional comparative advantage.

The outline of this study is as follows. Section two describes model used to study farmland values, income stabilization and moral hazard in Canadian agriculture. Section three describes the panel econometric methods used to estimate the model discussed in section two. A discussion of the results is given in section four, followed by concluding remarks in section five.

2. Farmland Values, Stabilization and Moral Hazard in Canadian Agriculture

Time-series analyses of farmland values have most often used the net present value (NPV) model. The NPV model explains capitalization of income streams into land values. The basic NPV model for a single income stream is

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

where V is the value of farmland, R is the returns to farmland, r is a constant discount rate, E is the expectations operator, and t denotes the time period. Under cointegration the long-run NPV model can be estimated independently of the short run dynamics of the model (Campbell and Shiller, 1987). By imposing a long-run steady state, the NPV model simplifies to

$$V_t = \frac{1+r}{r} R_t . \qquad (1)$$

Changes in land values and farmland returns can be modelled using a flexible autoregressive process.

As noted earlier government payments are an important source of income for Canadian producers. The study by Clark *et al.* (1993) was one of the first to consider Canadian government support payments in the capitalization model. The authors assumed that both income and support payments are capitalized at the same rate. Weersink *et al.*, (1999) relaxed this restriction by specifying separate discount rates for the two income streams. These studies ignore the possible inverse relationship between government payments and farmland returns. This relationship would occur if support policies were designed to stabilize producer revenues, as is largely the case in Canada. Because of the inverse relationship, single equation estimation of the farmland value model is under-identified when income and government payments are included as separate repressors.

Shaik *et al.* (2005) were the first to address the identification issue by modelling the factors related to the level of government payments, and estimating the NPV model simultaneously with the stabilization equation. When normalizing on government payments the coefficient on income reveals the long-run stabilization rate for farm income. For the model used by Shaik *et al.* (2005) identification was achieved because the model had a recursive structure. In the standard cointegration framework imposing restrictions on the covariance matrix of the residuals is not required. In the absence of cross equation restrictions, the cointegrating vectors are identified by imposing *k* restrictions on each of the *k* cointegrating vectors. In the case at hand, two restrictions must be imposed on the farmland value equation. One possibility is equal capitalization rates for income and government support. The equality restriction is supported by the results of studies such as Clark *et al.* (1993) and Turvey *et al.* (1995).

Both the government payments and stabilization models capture the long-run steady of the system. The short run dynamics of the system can also be estimated after the long-run components of the system have been removed. The error correction model (ECM) for farm income can be expressed as

$$\Delta R_t = \kappa + \eta_1 \varepsilon_{t-1} + \eta_2 u_{t-1} + \sum_{j=1}^{J} \tau_j \Delta Y_{t-j} + w_t \qquad (2)$$

Where $u_{i,t-1}$ and $\varepsilon_{i,t-1}$ are the lagged error terms from the stabilization and capitalization models, and $\Delta Y_{t-j} = \{\Delta R_{t-j}, \Delta G_{t-j}, \Delta V_{t-j}\}$. The error terms w_t are typically assumed to have constant variance. Testing if the variance of the errors in the ECM is correlated with past levels of government support provides a test of moral hazard, similar to the tests done by Goodwin and Vado (2007) using a conditional heteroskedastic autoregressive model. The heteroskedasticity can be modelled directly as $\sigma_i = \exp(z_i)$, where σ is the standard error of the estimates and

$$z_i = \sum_{j=1}^{J} a_j G_{i,t-j} .$$

Another issue in modelling farmland values is non-agricultural influences. A common theoretical model used to capture non-agricultural influence on farmland values is a basic extension of the standard NPV model, where a new non-agricultural stream of future net returns replaces the stream of agricultural returns at some conversion time (Capozza and Helsley, 1989). It is typically assumed that land is always converted away from agricultural, presumably because the high cost of converting land back to agriculture would deter back-conversion. The conversion time model can be expressed as

$$V_t = \sum_{i=0}^{\rho-1} \frac{E_t R_{t+i}}{(1+r)^i} + \sum_{i=0}^{\infty} \frac{E_t R^N_{t+\rho+i}}{(1+\tau)^{\rho+i}} \tag{3}$$

where R^N is the non-agricultural return to the land and ρ is the conversion time. Equation (3) can justify the inclusion of non-agricultural influences in time series analysis, but does imply an aggregation issue when working with aggregate data. To be amendable to aggregate data at the very least the distribution of the ρ's must be stationary across time so that the parameters of the closed form model are stable. Evidence of cointegration provides support of stable parameters and a stationary distribution for the ρ's.

Data on future non-agricultural returns to farmland is typically not available. Much of the most recent work on farmland values using cross-sectional data have identified suitable proxies such as distance to urban centres, population density, and residential housing starts (Taylor and Brester, 2005; Nickerson and lynch, 2001; Huang *et al.*, 2006). Recent times series analysis on farmland values have attempted to capture non-agricultural influences on farmland values across time and space. Shaik *et al.* (2005) and Weerahewa *et al.* (2008) find that average population characteristics such as non-farm income and population density have an influence on farmland values.

3. Panel Econometric Methods

Studies indicate that farmland values, government payments, and farmland returns are non-stationary, and therefore cointegration techniques should be used to estimate the stabilization and farmland value models (Gutierrez *et al.,* 2007; Engsted 1998). In this study we use non-stationary panel econometrics to estimate the average stabilization rates of farm income, and the capitalization of income and government payments into farmland values across Canadian provinces. Using provinces as panels increases the number observations for the analysis, and allows for testing heterogeneity in capitalization and stabilization across Canada.

Phillips and Moon (1999) discuss the properties of panel data models with non-stationary variables. Their results show that for non-stationary panel data one can estimate an average long-run coefficient using OLS, even if the panels are heterogeneous. However, if the panels are heterogonous the estimated long-run coefficients will not produce a cointegrating relationship across all panels. Therefore, when using non-stationary panel data, finding cointegration provides evidence in favour of the panels being homogeneous.

If the panels are homogenous and cointegrated, then superfluous non-stationary variables should not have any explanatory power in the cointegrating regression. Carrion-i-Silvestre and Sanso (2003) apply Park's (1990) J_1 variable addition test to panel data. If one assumes homogenous cointegration then the J_1 statistic is computed for the panel case similar to the single time-series case. The test statistic is computed as

$$J_1 = \frac{SSE^U - SSE^R}{\Omega_{u,z}},$$

where SSE^U is sums of squared errors of the unrestricted model, SSE^R is sums of squared errors of the restricted model, and $\Omega_{u,z}$ is an estimate of the long run variance from the canonical cointegration regression (CCR) (Park, 1992). In our analysis we consider higher ordered polynomial time trends as superfluous variables.

Assuming cointegration is found for the stabilization equation the farmland value equation will be specified as

$$V_{it} = b_0 + \gamma(R_{it} + G_{it}) + b_1 D_{it} + b_2 H_{it} + b_3 t_{it} + \varepsilon_{it} , \quad (4)$$

where V is the value of farmland, R is net income, G is government payments, and the proxies for additional non-agricultural influences are population density (D), the stock of residential housing units (H), and if needed a time trend (t). The implied discount factor r can be derived from the parameter estimate γ. This is calculated as $r = 1/(\gamma - 1)$. The subscript i denotes a particular province in Canada.

4. Data and Results

The data used in this study are annual observations on net farm income, net direct payments, farmland values, population density, and per capita housing starts, from 1971 to 2006 (Statistics Canada, 2007, various, and 2008a to 2000e). Panels were constructed using all provinces in Canada except Newfoundland. Because data for Newfoundland starts at 1974, including Newfoundland is the dataset would have resulted in only five additional observations. In addition, agriculture in Newfoundland is not as important as in other provinces in Canada. It was decide that the losses in observations for other provinces overshadowed the gains in observations by having Newfoundland in the data.

For each province net farm income was constructed from total farm revenues less total operating expenses. In the original data total farm receipts included farm program payments, and total operating expenses are net of government rebates. Therefore, total direct payments and total rebates where subtracted from income to avoid double counting of program payments. Net program payments are government payments net of program premiums paid by producers. Income and government payments are divided by total farm acres derived from the census of agriculture (Statistics Canada, 2007). All variables measured in monetary units are deflated using the GDP price index (2006 = 100). Population density is derived by dividing the estimates of population by the total land area for each province. Total housing starts are transformed by taking the cumulative sum of the series to capture the increase in the residential housing stock.

Table 1 presents the estimates and tests of cointegration for the stabilization equation, using data for all of Canada, the Maritimes (PEI, Nova Scotia, New Brunswick), Central Canada (Quebec, Ontario), Western Canada (Manitoba, Saskatchewan, Alberta), and BC (British Columbia). For the J_1 test of cointegration, we follow the advice of Park (1990) and choose up to three superfluous variables entered into the equations. The breakdown of provinces into various regions was based on cointegration tests. Originally all provinces where pooled, which resulted in a rejection of cointegration. This finding is consistent with significant heterogeneity across provinces with respect to stabilization and income support policies. It is interesting to note that the pooled estimate of the stabilization coefficient across all provinces is positive and significant whereas for all sub-regions the pooled stabilization estimates are negative and significant. Overall, these findings suggest that pooling heterogeneous panels can mask important regional heterogeneity, especially if individual fixed effects are not accounted for.

Since provincial homogeneity is rejected by the data, we hypothesized that provinces could be grouped into regions of similar geography and agricultural production. This resulted in the four regions: the Maritimes, Central Canada, Western Canada, and BC. Cointegration was not rejected for all regional stabilization models, indicating homogeneity in stabilization across regions.

Table 1. Panel canonical cointegrating regression results for the stabilization equation

Variable	Estimates [1]				
	Canada	Maritimes	Central Canada [2]	Western Canada[2]	British Columbia [2]
Constant	-4.884 (1.260)	12.203 * (2.007)	78.335 * (12.984)	17.894 * (13.491)	19.99 * (8.508)
Trend	0.898 * (6.625)	0.533 * (3.077)	--	--	--
R_t	0.107 * (3.365)	-0.085 (1.749)	-0.424 * (7.487)	-0.297 * (-7.237)	-0.233 * (-4.331)
Park's J_1 Test Statistic Superfluous variables:					
1	0.640	1.047	1.376	0.0906	0.071
2	4.893	2.986	1.534	3.665	2.972
3	12.837 *	3.555	2.595	6.923	6.375

[1] Values in parentheses are t-values
[2] The trend variable was found to be insignificant and was therefore excluded from the final regression
* Significant at the 5% level or higher
Maritimes is the provinces of PEI, Nova Scotia, New Brunswick; Central Canada is the provinces of Quebec and Ontario;
Western Canada is the provinces of Manitoba, Saskatchewan, and Alberta; and BC is the province of British Columbia

We find that an inverse long-run relationship exists between government support payments and farm income per acre, across all regions. Central Canadian producers receive the highest rate of stabilization, with every dollar decrease in income being offset by about $0.42 of support payments. The Maritimes receive by far the lowest rate of income stabilization, with only $0.08 of government support for every one dollar loss in income. Estimates for the stabilization rates in Western Canada and B.C. are approximately $0.30 and $0.23 for every dollar decline in farm income, respectively. The estimates reveal an interesting pattern of stabilization across provinces, with the coastal regions receiving the least stabilization, the inner provinces receiving the most stabilization, and the highest rate of stabilization in the industrial heartland of Canada.

Table 2 presents the estimates and tests of cointegration for the capitalization equation using data for all provinces studied. Since cointegration was not rejected for income and government support, we chose to add the two variables together in the land value equation. Cointegration was not rejected for the capitalization model when estimating across all provinces, indicating that the provinces must be homogeneous with respect to the capitalization of income and government payments into farmland values.

Based on the estimates for the restricted model, for every per acre dollar increase in income or government payments, farmland values will increase by $11.76, which translates to an implied discount factor approximately 9.29%. Table 3 gives the capitalization estimates for government support. The breakdown of support into provincial and federal amounts is based on an average of program spending in agriculture in crop years 2005-06 and 2006-07 (AAFC, 2009b). The estimates in Table 3 indicate that if government support where removed from Canadian agriculture significant decreases in farmland values would occur. The estimates show that for Quebec, Manitoba, and Saskatchewan farmland values would decrease by over 50%. The small decline estimated for Ontario and B.C. of 15.7% and 6.5%, respectively, is largely due to the non-agricultural influences on farmland values in these provinces. Total capitalization across provinces largely mirrors the geographic pattern found for stabilization, with Quebec and Ontario having the largest total support capitalization in agriculture in 2006.

Table 2. Panel canonical cointegrating regression results for farmland value equation

	Estimates [1]	
Variable	**Unrestricted Model**	**Restricted Model**
Constant	-394.792 *	-552.572 *
	(2.682)	(3.655)
$(R_t + G_t)$	10.703 *	11.758 *
	(9.226)	(11.017)
H_t	5.765 *	6.021 *
	(9.070)	(9.247)
D_t	-4.557	--
	(0.586)	
Park's J_1 Test Statistic		
Superfluous variables:		
1	0.004	0.371
2	1.557	1.457
3	1.884	1.592

[1] Values in parentheses are t-values
* Significant at the 5% level or higher

Table 3. Provincial farmland value capitalization estimates for government support payments

Province	Total Capitalization (2006 CAD/acre)		Contribution to Farmland
	Federal	Provincial	Value[1] (%)
PEI	150.73	169.97	17.04
Nova Scotia	78.70	96.19	14.62
New Brunswick	207.29	176.58	32.98
Quebec	468.20	620.63	53.11
Ontario	309.26	242.99	15.70
Manitoba	210.29	152.28	63.28
Saskatchewan	111.34	84.00	55.02
Alberta	80.19	102.06	20.95
British Columbia	98.54	71.35	6.46

[1] Values are the proportion of farmland value contributed to support payments in 2006

Table 4 gives the results for the income model estimated across all provinces. The number of lags for the model was determined using the Schwarz information criterion (Schwarz, 1978), using a maximum lag length of five. The lagged error terms were constructed from the errors of the farmland value equation and the four stabilization equations. Of interest in Table 4 are the estimates of the variance equation. The positive and significant estimates for government support in the variance equation indicate that the variance of income is increased when past government support rises. This finding is further substantiated by the likelihood ratio test of restrictions. The restricted model is rejected ($\alpha = 0.05$) in favour of the model with non-constant variance. Table 5 presents estimates of the income variance elasticity to changes in past government support, estimated at the 2006 level of government support for each province. The estimates reveal relative distortions in average farm income due to government support. There is wide range of income variance effects across regions, with elasticity estimates ranging from 0.29% to 1.9%. Not surprisingly the provinces with the largest support to producers have the largest elasticity estimates. For example, in Quebec and Ontario a one percent increase in government support will increase the variance of farm income by about 1.9% and 0.95%, respectively. Overall, the results suggest that agricultural support policies are creating a moral hazard problem that varies substantially across provinces.

Table 4. Maximum likelihood estimates for short-run income model

	Unrestricted Model[1]		Restricted Model[1]	
	Estimate	**t-value**	**Estimate**	**t-value**
Constant	-3.58	1.42	-3.76	1.38
ε_{t-1}	-0.22	2.06 *	-0.23	2.19 *
u_{t-1}	-0.000	0.16	-0.001	0.34
ΔR_{t-1}	-0.29	5.53 *	-0.30	5.42 *
ΔV_{t-1}	-0.001	0.07	0.002	0.09
ΔG_{t-1}	0.055	0.37	0.04	0.36
ΔH_{t-1}	0.22	0.34	0.08	0.11
ΔR_{t-2}	-0.34	6.55 *	-0.34	6.31 *
ΔV_{t-2}	-0.02	1.20	-0.03	1.58
ΔG_{t-2}	-0.17	1.16	-0.15	1.20
ΔH_{t-2}	-0.08	0.13	0.05	0.07
Variance Equation				
Constant	2.83	37.98 *	3.06	74.52 *
ΔG_{t-1}	0.002	0.70		
ΔG_{t-2}	0.01	2.68 *		
Log-Likelihood		-1322.60		-1329.49
L.R. Test				13.78 *

[1] Dependent variable is ΔR_t.
* Significant at the 5% level or higher

Table 5. Provincial farm income variance elasticity estimates

Province	Variance Elasticity [1]
PEI	0.554
Nova Scotia	0.302
New Brunswick	0.663
Quebec	1.880
Ontario	0.953
Manitoba	0.626
Saskatchewan	0.337
Alberta	0.315
British Columbia	0.293

[1] Values are the elasticity of income variance with respect to changes in past government support.

6. Conclusions

Increases in the level of monetary transfers from tax payers to agricultural producers, suggests that evaluating the costs and providing estimates of the transfer efficiency of government support is an important area of research. The objective of this paper is to estimate three measures of transfer efficiency, namely (1) the capitalization of support into farmland values, (2) the rate of income stabilization, and (3) the effect of past government support on the variance of income. Estimates for these measures were calculated from provincial time series data.

In this study we used non-stationary panel econometrics to estimate the farmland value and stabilization models. By using the properties of panel cointegration tests, we identify that the capitalization of income and government support is the same across Canadian provinces, and the rate of stabilization varies across regions. We conclude that the effect of government payments on the wealth position of agricultural producers is the same across provinces, and that differences in the capitalization of government support are due to differences to the overall level of support given in each province. Based on the results we find that if government support payments were eliminated there would be a substantial wealth reduction for current producers but a major cost reduction for the next generation of producers.

Results also show significant differences between Canadian regions in the effectiveness of stabilization. There is a significant inverse relation between government support payments and farm income across all regions. However, for the Maritime Provinces there is a noticeable lower rate of stabilization, as well as an unexplainable upward trend in support. Results for the third objective show that the variance of income is significantly correlated with past levels of government payments. This indicates that government support is motivating producers to make risky decisions, thus creating a moral hazard problem in the Canada agriculture sector. Overall, the estimated heterogeneity in stabilization and variance effects indicates that significant regional differences exist across Canada.

Understanding the economic consequences of these differences will require further empirical work.

The intercept and especially trend terms in the stabilization equation captures the level of government payments unrelated to income (i.e. possible rent seeking). Based on the estimates, unobserved factors generate significantly more government support for producers in Central Canada. Results also show an upward trend in government payment in the Maritimes that does not exist in other regions. This result is surprising, since federal agricultural policy has largely been concerned with farm income issues outside the Maritime region (Skogstad, 2008). In addition, given constraints on fiscal spending for the Maritime region coupled with the small population, it is unlikely the region has the resources or federal lobbying power to promote the increased direct payments to producers over time. It may be the case that trends in government support related to income concerns in other regions are having a spill over effect in the Maritime Provinces. It is important to note that, although rent seeking is increasing in the Maritimes, the level of rents received from government in the region is estimated to be less then half of what was received in Central Canada in 2006.

The results of this study provide policy makers and other analysts a set of estimates regarding the transfer efficiency of agricultural programs and the associated market risk premium. This study also demonstrates that panel non-stationarity provides a consistent method for identifying heterogeneous panels. Further research such as a cross-country comparison could provide an insightful international comparison on the capitalization of program payments into farmland values, and the political-economy of agricultural support. Further developments are also needed to identify the determinants of farmland values and government support in Canada, so to better explain the observed trends.

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