International Effects of Canada's Western Grain Stabilization Program

D. Lynne Cameron and John Spriggs

Canada's Western Grain Stabilization Program is analyzed to determine the extent to which it acts as a buffer between the Canadian grains economy and the international grains economy. A dynamic stochastic simulation model is constructed to examine how Canada's Western Grain Stabilization Program modifies the transmission of: (*a*) domestic yield variability to the foreign grain market and (*b*) foreign demand variability to the domestic grains market. With respect to (*a*), the program was found to aggravate international uncertainty only very slightly while with respect to (*b*) it was found to substantially reduce domestic uncertainty.

Key words: dynamic stochastic simulation, grains, stabilization.

In recent years, it has become increasingly apparent that domestic agricultural support programs in a number of countries have contributed to a crisis in the international grains market. In fact, at the Uruguay round of the General Agreement on Tariffs and Trade negotiations, domestic farm programs were placed at the top of the agenda. In addition to this political initiative, and partly to support it, many trade economists have attempted to assess the international effects of domestic farm policies. These studies have tended to focus in two areas. They are: (*a*) the effects of agricultural protection in general (Organization for Economic Cooperation and Development; Tyers and Anderson 1988b; Parikh et al.; Roningen and Dixit) and (*b*) the effects of specific approaches to agricultural policy (Bureau of Agricultural Economics; Roberts et al.). This article falls into the second of these areas.

Within this area, the objective has usually been to show how particular approaches to agricultural policy can have harmful effects on other countries and to suggest alternative approaches which are less harmful. For example, Roberts et al. argue that the U.S. policy of competitive subsidization has significantly harmed competing exporters and that a less harmful alternative would be tradeable support entitlements.

In Canada, the Western Grain Stabilization Program (WGSP) has been widely touted as a method of agricultural support which is relatively harmless to other grain exporters but which does a good job in filtering out the effects of foreign market instability on domestic grain producers. However, there has been no previous study of the international effects of this program. The purpose of this article is to attempt to at least partially fill this void. We examine this policy as a potential influence on the transmission of market instability between the domestic and foreign markets. We consider how this policy affects: (*a*) the transmission of domestic (yield) instability to the foreign grain market and (*b*) the transmission of foreign (demand) instability to the domestic market.

Conceptual Framework

The WGSP was introduced in Canada in 1976 as a way of reducing the income instability facing prairie grain producers. The WGSP is distinguished from many other stabilization programs in that, instead of trying to stabilize price, it attempts to stabilize grain producers' net cash flow. Net cash flow is determined on a prairie-wide basis as the difference between the eligible gross grain receipts and expenses. If net cash flow falls below the five-year av-

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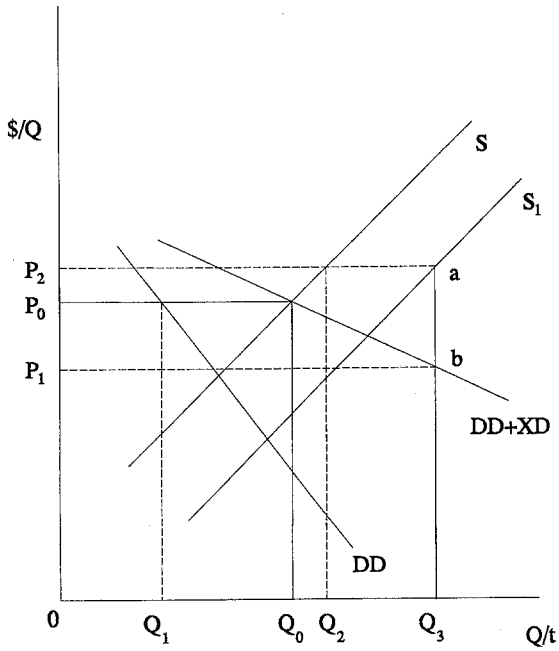

Figure 1. Simple market model showing the effects of the Western Grain Stabilization Program

erage, participants receive a payout from a stabilization fund. It is a voluntary program, financed partly by contributions from participants and partly by the federal government. The participants' contribution is a specified percentage of gross grain receipts (around 2% per year). It is determined by a formula which adjusts the contribution depending on the financial health of the stabilization fund. (For further details see Spriggs; and Spriggs and Van Kooten.)

The effects of the WGSP are illustrated with the aid of the partial equilibrium model of figure 1. The commodity considered in this market model is a composite of the seven prairie grains covered by the WGSP.[1] In this figure, we focus on the conceptual relationships between current quantities and current prices. Note that here (and in the subsequent empirical analysis), price refers to a production-weighted average across the seven grains.[2] Grain producers are assumed to face an upward-sloping planned supply curve (S) and a downward-sloping total demand curve (D). Total demand is the horizontal summation of domestic demand for consumption and inventories purposes (DD) and export demand (XD).

In this graphical model, in the absence of the WGSP, producers will plan to supply Q_0 and export ($Q_0 - Q_1$) at an equilibrium price of P_0. The WGSP may have two effects that can be represented using the comparative statics of figure 1. The two effects are a rightward shift in the planned supply curve from S to S_1 and a movement up along the planned supply curve. The net result of these two effects is a change in equilibrium from (P_0, Q_0) to (P_2, Q_3). The explanation of these two effects is as follows.

A shift in the planned supply curve may result if the stabilization program affects producer income risk. If producers in general are risk averse, the existence of a risk-reducing stabilization program shifts the planned supply curve to the right.

If producers have first-order (positive) autoregressive expectations of the aggregate payout, a movement up the planned supply curve may result. Such expectations imply that a large payout this year would lead to the expectation of a large payout next year. And, according to the rules of the program, an individual producer's payout depends on the size of his or her levy contributions (lagged) which in turn depends on his or her grain output. Thus he/she has an incentive to increase output this year as a way of increasing the share of expected payout next year. Algebraically, we can obtain this result from the following simple profit maximization problem. The producer is assumed to maximize expected profits (π) in year t, where:

$$\pi = P^* \cdot Q + PAY^* + \beta \cdot PAY^*_{+1} - C,$$

and where P^* is the expected per-unit value of grain in the year t, Q is the planned quantity of grain output in year t, PAY^* is the WGSP payout to the individual in year t, PAY^*_{+1} denotes the expected WGSP payout to the individual in year $t + 1$, β is the discount rate, and C represents grain-related costs of production in year t. In this profit maximization problem, output for year t is planned in year $t - 1$ and so producer expectations are also

[1] These grains are wheat, barley, oats, rye, flax, canola, and mustard. They represent all cash crops grown on the prairies except for specialty crops. Beginning in 1988, the WGSP extended coverage to a number of these specialty crops.

[2] The use of a production-weighted average price is easily defensible on the supply side of the model. It may be less defensible on the demand side where it could be argued that consumption/use weights would be more appropriate.

made in year $t - 1$. This reflects the biological lag in agricultural production. Costs are assumed to be known with certainty at the time planting decisions are made. The values expressed in this maximization problem are denominated in year t dollars.

According to the stabilization rules of the WGSP, the individual's payout (PAY) is equal to the aggregate prairie-wide payout ($APAY$) multiplied by the individual's share of total contributions to the stabilization fund during the previous three years. From the individual's perspective, the only way in which his/her share of total contributions can be adjusted is by changing output. The individual can do nothing to affect payout in the current year. But if a large aggregate payout is expected next year, the individual may attempt to increase his/her expected payout by increasing output in the current year. Suppose we then assume:

$$PAY^*_{+1} = APAY^*_{+1} \cdot SHARE, \quad \text{and}$$
$$SHARE = m \cdot Q + n,$$

where $APAY^*_{+1}$ is the aggregate payout from the WGSP expected next year, $SHARE$ is the individual's share of total contributions and m and n are parameters. And suppose that the individual's expectation of aggregate payout next year ($APAY^*_{+1}$) is first-order autoregressive. Then we can rewrite the expected profit function as:

$$\begin{aligned}\pi &= P^* \cdot Q + PAY^* + \beta \cdot (r + s \cdot APAY^*) \\ &\quad \cdot (m \cdot Q + n) - C \\ &= (P^* + \beta \cdot r + \beta \cdot s \cdot APAY^*) \cdot Q \\ &\quad + (PAY^* + \beta \cdot r \cdot n) - C,\end{aligned}$$

where r and s are parameters. Maximization of this function requires that the individual's expected marginal revenue ($P^* + \beta \cdot r + \beta \cdot s \cdot APAY^*$) equals marginal cost ($\delta C/\delta Q$). But note that the individual's expected marginal revenue is a function of the current period's expected aggregate payout. With respect to figure 1, this effect is represented by the price difference ($P_2 - P_0$).

In summary, the presence of the WGSP may result in two supply-enhancing effects. In the model represented in figure 1, these effects also imply a reduction in the market equilibrium world price to P_1. And domestic producers can also expect to receive area $P_2\, a\, b\, P_1$ as a transfer payment from the government.

In the following we specify and estimate a model of the prairie grains economy using econometric methods and the historical sample period 1966 to 1986. Then we simulate the model to explore the international effects of the WGSP. Following Spriggs, we use the methodology of dynamic stochastic simulation. This methodology is particularly useful for analyzing the effects of such policies. Not only can it address the two comparative static effects represented in figure 1, but it can also analyze the dynamic effects which arise from the use of moving-average stabilization rules. These moving-average rules tend to moderate the effect of market shocks on expectations. In the first simulation exercise we examine how the WGSP modifies the transmission of domestic production uncertainty to the foreign market. In the second simulation exercise we examine how the WGSP modifies the transmission of foreign demand uncertainty to the domestic market.

Model Specification

The simulation model is as follows:

$$HA = \alpha_0 + \alpha_1 P^* + \alpha_2 APAY^* + \alpha_3 CCNUM + \alpha_4 D1 + \alpha_5 D2, \tag{1}$$

$$QP = HA \cdot (YLD + u), \tag{2}$$

$$QDD = \beta_0 + \beta_1 P + \beta_2 INC + \beta_3 QDD_{-1}, \tag{3}$$

$$QDS = \tau_0 + \tau_1 (P^*_{+1} - P), \tag{4}$$

$$QDX = \delta_0 + \delta_1 P + v, \quad \text{and} \tag{5}$$

$$QP + QPNP + QDS_{-1} = QDD + QDS + QDX. \tag{6}$$

HA is the area planted to the seven WGSP crops in the Canadian prairies (thousand hectares). P^* is the producers' expected per-unit average return from the seven crops ($ per tonne). This variable is estimated assuming autoregressive expectations as discussed below. $APAY^*$ represents producers' expected aggregate (prairie-wide) payout from the WGSP ($ thousand). This variable is estimated as discussed below. $CCNUM$ denotes cattle and calf numbers in western Canada (thousands). $D1$ is a dummy variable for the LIFT (Lower Inventories for Tomorrow) program. It takes on a value of one in 1970 and zero otherwise. $D2$ is a dummy variable for the WGSP program. It takes on a value of one for the years beginning 1976 when the WGSP was introduced and zero otherwise. QP is production of the seven grains (thousand tonnes). YLD represents yield of the seven grains (tonnes per hect-

are). u is the stochastic error term for the first simulation exercise. QDD represents domestic use of the seven grains (thousand tonnes). P is the per-unit average return from the seven crops ($ per tonne). INC is personal disposable income in Canada ($ million). QDS is year-ending inventory of the seven grains (thousand tonnes). P^*_{+1} is producers' expected per-unit average return from the seven crops ($ per tonne) in the next year. This variable is estimated assuming autoregressive expectations. QDX denotes Canadian exports of the seven grains (thousand tonnes). v is the stochastic error term for the second simulation exercise. $QPNP$ is nonprairie production of the seven grains (thousand tonnes). QDS_{-1} is the beginning inventory of the seven grains (thousand tonnes). The exogenous variables are $CCNUM$, $D1$, $D2$, YLD, INC, and $QPNP$.

Equation (1): Area Response (*HA*)

The dependent variable in equation (1) represents planned output. The equation is estimated using OLS regression. The specification of this equation involves the following variables:

(*a*) P^* is obtained as the fitted values from a first-order autoregressive equation in price. The second-order autoregressive variable was not found to be significant at the 5% significance level. Thus:

$$P^* = 24.12 + .8191P_{-1}. \tag{7}$$

(*b*) $APAY^*$ is obtained from the solution of a submodel of the WGSP variables determining $APAY$ and where actual values in the current year are replaced by assumed producers' expected values. The submodel is:

$$APAY^* = \text{Max}\{0, PPAY^*\}, \tag{8}$$

$$PPAY^* = PR^* \cdot \left[\left(\sum_{i=1}^{5} NCF_{-i}\right) \Big/ 5 - NCF^*\right], \tag{9}$$

$$NCF^* = ER^* \cdot [GGP^* - GGE^* \cdot MPR^*], \tag{10}$$

$$GGP^* = GM^* \cdot P^*, \tag{11}$$

$$GM^* = 3{,}975 + .8754GM_{-1}, \text{ and} \tag{12}$$

$$GGE^* = 92.61 + 1.578GGE_{-1} - .5982GGE_{-2}. \tag{13}$$

In this submodel, $APAY^*$ is assumed to be equal to potential payout ($PPAY^*$) whenever this is greater than zero. $PPAY^*$ is assumed to be equal to the expected participation rate in the program (PR^*) multiplied by the shortfall of expected eligible net cash flow from grain production below the preceding five-year average $[(\sum_{i=1}^{5} NCF_{-i})/5 - NCF^*]$. NCF^* is assumed to be equal to the difference between expected gross grain proceeds (GGP^*) and expected gross grain expenses on marketed grain ($GGE^* \cdot MPR^*$) adjusted by the expected eligibility ratio (ER^*). GGE^* represents expected gross grain expenses. This is multiplied by the expected marketing-production ratio (MPR^*) to reflect the fact that not all produced grain is marketed (e.g., that which is fed to livestock). ER^* reflects the fact that some producers are ineligible (such as landlords and noncitizens), and some grain receipts of eligible producers are ineligible (i.e., those in excess of the established cap). Expected gross grain proceeds (GGP^*) is assumed to be equal to expected grain marketings (GM^*) multiplied by expected price (P^*). GM^* is obtained as the fitted values from a first-order autoregressive equation in grain marketings. The second-order autoregressive variable was not found to be significant at the 5% significance level. GGE^* is obtained as the fitted values from a second-order autoregressive equation in gross grain expenses. The third-order autoregressive variable was not found to be significant at the 5% significance level. For the other variables in this submodel (ER^*, PR^*, and MPR^*), naive expectations are assumed. These variables are generated by the Western Grain Stabilization Administration (WGSA) specifically for the WGSP and hence producers do not have a long history of the variables from which to form their expectations. In addition, the variables do not change much from year to year. The coefficients of variation for ER^*, PR^*, and MPR^* over the sample period (1976 to 1986) are .06, .02, and .05, respectively. One implicit assumption in the use of this submodel is that producers treat the expectational variables as independent of one another. This assumption may be justified on the basis of information constraints. Data on the lagged values of variables in this submodel are readily available in various issues of Agriculture Canada's *Western Grain Stabilization: Annual Report*. However, it appears that there have been no attempts to generate information on the correlation among these variables.

(*c*) *CCNUM* represents the substitution possibilities between livestock and grain production on the prairies. Thus, for example, during the mid-1970s when the relative profitability of cattle to grain production shifted in favor of grain, there was a substantial switch from cattle production into grain production.

(*d*) The variable *D*1 reflects the depressing effect on area planted to grains in 1970 as a result of the federal government's LIFT program. This was a single-year program in which farmers were paid not to produce wheat.

(*e*) The variable *D*2 reflects the possibility that the WGSP will increase grain acreage by reducing risk to producers.

In summary, note that equation (1) allows for two separate effects of the WGSP on area planted to grains. First, it allows for the effect of the expectation of a payout and, second, it allows for the effect of the expected reduction in income risk.

The estimated area response equation is shown below. All coefficients in this equation have signs that are expected. All coefficients except the one associated with *D*2 are significant at the 10% significance level. The variables related to the WGSP are *APAY** and *D*2. The coefficient on *APAY** suggests that an increase in the expectation of a payout of $100 million in a given year leads to an increase in grain area of 1.63 million hectares (about 8%). The coefficient on *D*2 suggests that the presence of the WGSP has led to a permanent increase in grain area of 759,000 hectares (about 4%). This may be explained by the WGSP's ability to reduce income risk together with a presumed tendency of agricultural producers to be risk averse. The coefficients on *APAY** and *D*2 do not look unreasonable in magnitude. However, one should be careful not to overstate the result for *D*2. The variable used to pick up the risk-reducing effect of the WGSP is a dummy variable. It is not very significant and could be picking up the effect of other factors affecting planted area such as technological advance. It is suggested that further research is warranted in the specification of this effect.

Equation (2): Production Identity (*QP*)

This imposes the requirement that production equals area multiplied by yield. In the first simulation, yield is subjected to random perturbations.

Equation (3): Domestic Demand (*QDD*)

The variables in this equation are fairly straightforward. With respect to the price variable, it is endogenous to the model (but see footnote 2). To avoid the effects of correlation with the error term on the parameter estimation, instrumental variables estimation is used. The instrument chosen for the price variable is obtained as the fitted values from the OLS regression of price on the predetermined and exogenous variables in the model.

The income variable reflects the notion that, for normal goods, as income rises in an economy, so does the quantity consumed, *ceteris paribus*. The lagged *QDD* variable reflects the data that users of grain only partially adjust consumption in a given period to their desired level as a result of habit persistence or costs of adjustment. The estimated equation is shown at the top of the next page.

Equation (4): Inventory Demand (*QDS*)

The explanatory variable in this equation is the difference between the expected price next

Regressor	Coefficient	*t*-Value	Elasticity[a]
Constant	24,020	17.05	
*P**	20.98	4.28	.13
*APAY**	.00163	1.86	.03
CCNUM	−.9285	−5.50	−.39
*D*1	−4,194	−6.12	
*D*2	758.8	1.50	
$\bar{R}^2 = .920$, D.W. = 1.91, $N = 20$ (1967/68 to 1986/87)			

[a] Calculated at the observation means.

Regressor	Coefficient	t-Value	Elasticity[a]
Constant	4,270	1.43	
P	−20.27	−3.15	−.15
INC	.0939	3.35	.09
QDD_{-1}	.8209	4.23	
$\bar{R}^2 = .574$, $h = 0.26$, $N = 20$ (1967/68 to 1986/87)			

[a] Calculated at the observation means.

year and the current price. It is expected that ending stocks of grain would be positively related to this variable. The lower the current price is relative to the expected price next year, the greater the incentive to hold stocks in expectation of making a speculative gain. The expected price variable is the same as that used in the supply equation except carried forward one period. Since this price difference variable includes the current price which is endogenous to the model, instrumental variables estimation was again used here. The estimated equation is shown below.

Equation (5): Export Demand (QDX)

We were unable to successfully estimate an export demand equation for Canadian prairie grains. The main problem with estimating such an equation is the large number of exogenous factors affecting export demand. Export demand is affected by changes in supply and demand conditions in the rest of the world and these are numerous. Thus for this study, the export demand equation is derived under assumed values for the export demand elasticity (ϵ).

This export demand elasticity is for prairie grains covered by the WGSP. This includes wheat, coarse grains, and oilseeds (primarily canola). Assuming that the price transmission elasticities (of wheat, coarse grains, and canola prices with respect to prairie grains price) are equal to one, ϵ for prairie grains is a weighted average of the export demand elasticities for wheat, coarse grains, and canola. Thus:

$$\epsilon = a_1 \cdot \epsilon(W) + a_2 \cdot \epsilon(CG) + (1 - a_1 - a_2) \cdot \epsilon(C),$$

where a_1 is the ratio of prairie wheat exports to prairie grain exports. Over the simulation period, its value is about .65. a_2 is the ratio of prairie coarse grain exports to prairie grain exports. Over the simulation period, its value is about .25. $\epsilon(W)$ is the export demand elasticity for prairie wheat, $\epsilon(CG)$ is the export demand elasticity for prairie coarse grains, and $\epsilon(C)$ is the export demand elasticity for prairie canola.

From a review of literature, there have been very few studies which can provide some information on what range of values would be reasonable. With regard to Canadian wheat, Capel and Rigaux provided estimates (with respect to major importers) at around −1.5. However, in more recent studies, Tyers and Anderson (1988a) estimated the export demand elasticity at −6.6, while Ahmadi-Esfahani provided estimates (with respect to major importers) at around −5. The estimate by Tyers and Anderson refers to adjustments after one year.

With regard to coarse grains, we were unable to locate any specific estimates of the export demand elasticity. However, this is not too surprising as Canada is a relatively small ex-

Regressor	Coefficient	t-Value	Elasticity
Constant	17,970	20.28	
$P^*_{+1} - P$	623.3	6.08	4.06[a]
$\bar{R}^2 = .594$, D.W. = 1.39, $N = 20$ (1967/68 to 1986/87)			

[a] This elasticity, calculated at the observation means, is with respect to current price.

porter of such grains accounting for less than 10% of the quantities exported by the United States. The conventional wisdom is that the export demand for coarse grains is very elastic and indeed more elastic than the export demand for wheat. Tyers and Anderson (1988b), while not providing a specific estimate, suggest that it is greater than −40.

With regard to canola, the only estimates we could find of an export demand elasticity are −.3 (short run) and −.6 (long run) from Agriculture Canada (1980).

For the purposes of this study, we assume two alternative values for ϵ for prairie grains (−2 and −10). It is hoped that these will span the range of values within which readers expect the true elasticity to lie.

Given these assumed export demand elasticities, equation (5) is fitted through the mean historical price and export values. Export demand is subject to random perturbations in the second simulation.

Equation (6): Supply-Utilization Identity

This equation imposes the requirement that at equilibrium the quantity supplied to the market must equal the quantity demanded.

Model Simulation Results

The simulation model consists of equations (1) to (13). In this model, current price (P) is endogenous to equations (1) to (6). In equation (7), the solution value for P helps to determine P^* in the following year. This in turn affects planned output [equation (1)] in two ways: directly since P^* is an explanatory variable in equation (1) and indirectly since it helps to determine $APAY^*$ through equations (8) to (11). The preceding model is simulated over the historical period, 1976 to 1986. The first year of the simulation coincides with the first year of the WGSP. Each simulation run uses 100 replicates to generate the stochastic results. This number was found to be sufficient to render the results insensitive to the choice of start values for the random number generator.

In the simulation analysis, two scenarios are considered. They are the WGSP scenario (i.e., what actually occurred) and the "no WGSP" scenario. For each scenario, two simulations are conducted which deal with the international effects of the WGSP. The first explores how the WGSP modifies the transmission of domestic yield variability to the foreign market. The second explores how the WGSP modifies the transmission of foreign demand variability to the domestic market. The results of the two simulation experiments are summarized in figures 2 to 5. In each of these figures, there are two pairs of lines. The solid lines refer to the WGSP scenario while the dashed lines refer to the "no WGSP" scenario. Each pair of lines represents the range of simulation values one standard deviation from either side of the mean.

Simulation 1: Domestic Yield Variability

For this simulation, equation (2) of the simulation model includes the random error term (u). It is assumed that domestic grain yield is a normally distributed random variable with mean and standard deviation estimated from sample yield data for the period 1966 to 1986. Unbiased estimates of the mean and standard deviation are 1.77 and .20 tonnes per hectare, respectively. The results of the simulation are summarized in figure 2 (for $\epsilon = -2$) and figure 3 (for $\epsilon = -10$). In this model, the effects of domestic yield variability are assumed to be transmitted internationally to grain exports and grain price. The estimated impacts of the WGSP on the transmission of domestic yield variability to these variables are summarized in panels (a) and (b), respectively.

With respect to the volume of grain exports [figures 2(a) and 3(a)], the WGSP results in generally higher mean levels. This may be attributed to the estimated production-enhancing nature of the program. Over the 11-year period, the estimated average increase in mean exports is about 10% under both assumptions about ϵ. The variability in exports due to domestic yield variability appears to be slightly exacerbated by the WGSP. Under both assumptions about ϵ, export variability (as measured by the standard deviation) increases on average by about 5% as a result of the WGSP.

With respect to grain price [figures 2(b) and 3(b)], the WGSP results in slightly lower mean levels. Under the less elastic export demand assumption, the average reduction is less than 5%. Under the more elastic export demand assumption, this effect is negligible. The effect of the WGSP on the variability in grain price is negligible under either assumption about ϵ.

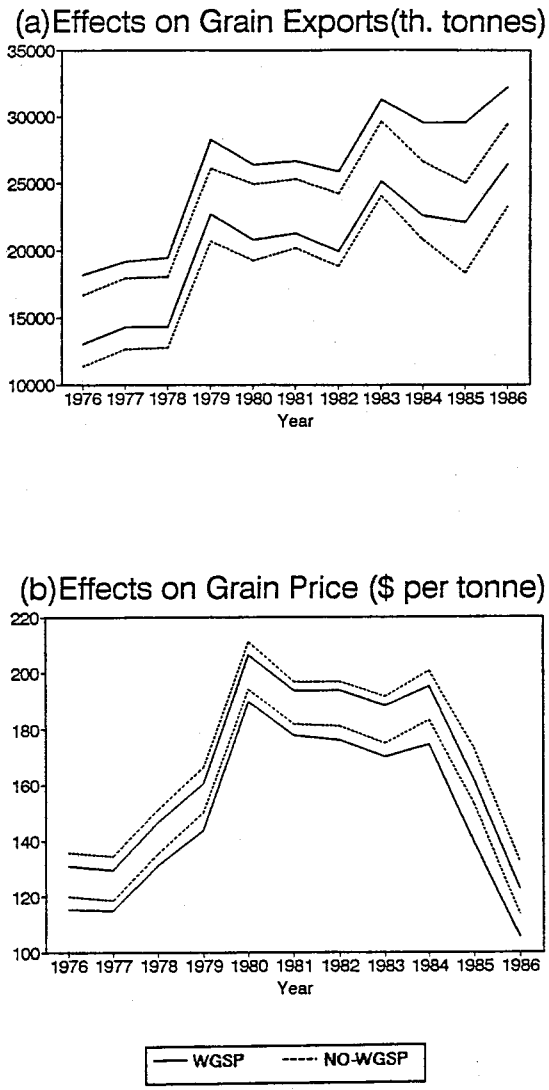

Figure 2. Effects of domestic yield variability ($\epsilon = -2$)

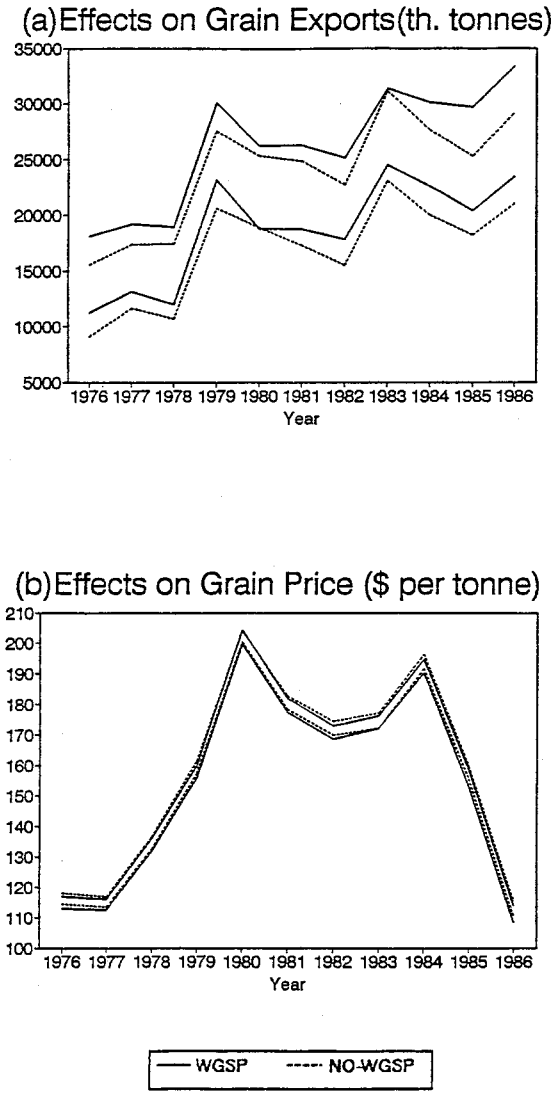

Figure 3. Effects of domestic yield variability ($\epsilon = -10$)

Simulation 2: International Instability

For this simulation, equation (5) of the simulation model includes the random error term (v). It is assumed to be normally and independently distributed with a mean of zero and a standard deviation estimated from the data for the period 1966 to 1986. The estimated standard deviation depends on the assumed ϵ. For export demand elasticities of -2 and -10, the estimated standard deviations are 21,700 and 92,500, respectively. The results of the second simulation exercise are summarized in figure 4 ($\epsilon = -2$) and figure 5 ($\epsilon = -10$). In this model, the effects of foreign demand variability are assumed to be transmitted to the domestic market through prairie grain production, grain price, and producer gross revenue from grain production. The estimated impacts of the WGSP on the transmission of foreign demand variability to these variables are summarized in panels (a), (b), and (c), respectively.

With respect to prairie grain production [figures 4(a) and 5(a)], the WGSP results in generally higher mean levels. Under either ϵ assumption, the mean production-enhancing

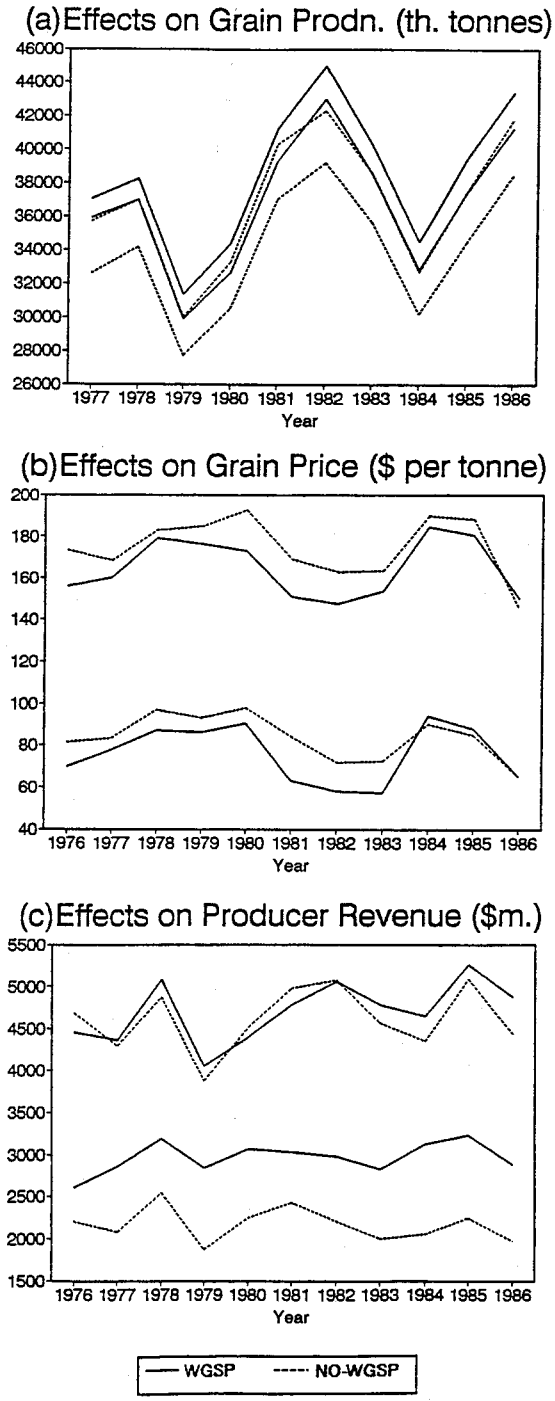

Figure 4. Effects of foreign demand variability ($\epsilon = -2$)

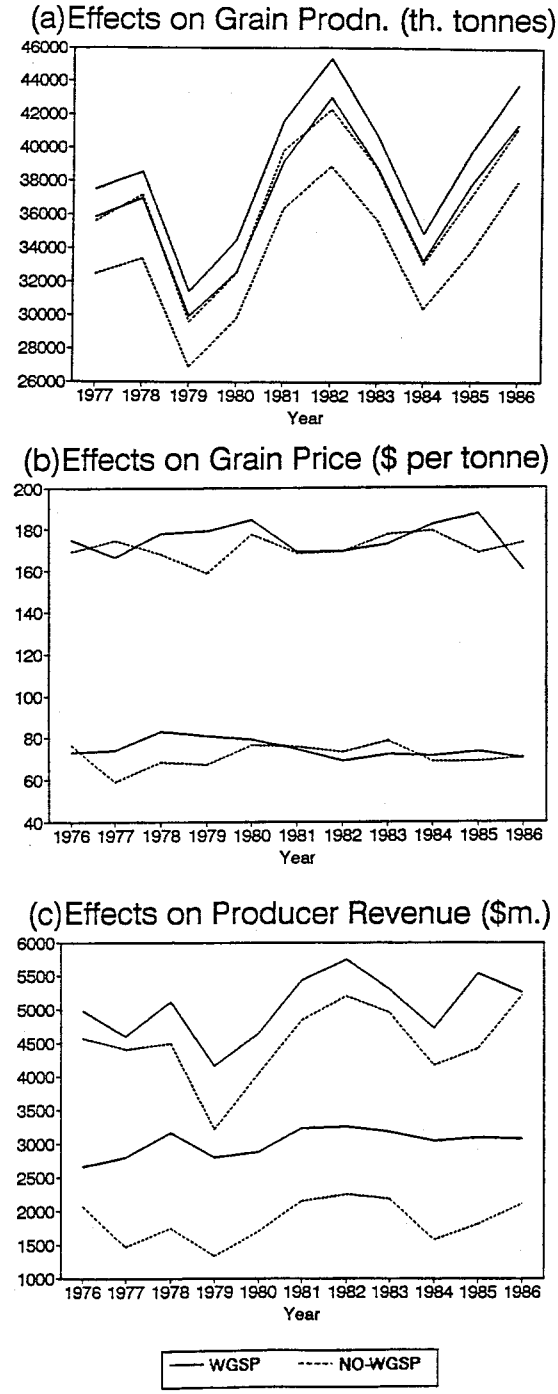

Figure 5. Effects of foreign demand variability ($\epsilon = -10$)

effect of the WGSP amounts to around 7%. The WGSP appears to have a substantial impact on the transmission of foreign demand variability to domestic production variability.

According to the model, the foreign-induced variability in prairie grain production is reduced by 42% when $\epsilon = -2$ and by 38% when $\epsilon = -10$. It appears that the WGSP is quite

successful in filtering out the effects of international instability on domestic production.

With respect to grain price [figures 4(b) and 5(b)], the WGSP results in lower mean levels. This is associated with the predicted production-enhancing effect of the program. When $\epsilon = -2$, the average price reduction is 7%, while when $\epsilon = -10$, the average price reduction is negligible. The WGSP appears to have no clear impact on the transmission of foreign demand variability to grain price variability.

With respect to producer gross revenue [figures 4(c) and 5(c)], the WGSP results in higher mean levels and less variability. When producer revenue is low, the WGSP appears to be particularly successful in raising the level and evening out the fluctuations over time. This is suggested by a comparison of the bottom two lines in each figure. These two lines show the simulated producer revenue, one standard deviation below the mean, under the WGSP and "no WGSP" scenarios. By contrast, when producer revenue is high, the WGSP appears to be only modestly successful in raising the level and evening out the fluctuations over time. Overall, because of the WGSP, average producer revenue is expected to increase by 13% when $\epsilon = -2$ and by 27% when $\epsilon = -10$. At the same time, the variability in producer revenue is expected to decrease by 29% and 23%, respectively. In summary, the WGSP is successful in filtering out the effects of foreign demand instability on domestic producer revenue. This is particularly the case when foreign demand is depressed.

Limitations of the Analysis

This study examines the international effects of a unilateral Canadian policy decision with respect to the WGSP. As such it treats other countries' policies as given. Thus, for example, we need to exercise some caution when we conclude that the WGSP is successful in stabilizing domestic producer revenue. If all countries were to multilaterally remove their protection of grain producers, prices themselves might fluctuate less and this in turn might contribute to greater stability of Canadian producer revenue.

A second limitation is the use of autoregressive expectations in the estimation of the model. There may have been some gains to be had from the use of Muthian rational expectations with all its implied parameter constraints.

A third area to flag for possible further research is the specification of the supply equation. This equation is central to the empirical results and our specification is only a first approximation.

Conclusions

In this article, a simple market equilibrium model of the prairie grains economy was constructed to assess the international effects of the WGSP. The specific stabilization rules of the WGSP were incorporated into the simulation model in such a way that they were permitted to influence grain production decisions on the prairies. Conceptually, this article suggests that there are at least two reasons why the WGSP may distort supply and so have international effects. First, if producers are risk averse with respect to income, then a government program of this nature would provide an incentive to producers to shift resources from more risky investments into grain production. Second, the expectation of a payout itself may encourage additional planned production.

Dynamic stochastic simulation is performed on the model to examine how the WGSP modifies the transmission of: (*a*) domestic yield variability to the foreign grains market and (*b*) foreign demand variability to the domestic grains market. For each of these two simulation exercises, the model is run with and without the WGSP in place and the results compared. The model is simulated over the period 1976 to 1986 using 100 replicates.

The international effects are assessed in terms of the mean level and mean variability of selected variables. The mean level effects of the WGSP are largely as expected. Under the WGSP it is predicted that grain production and grain exports tend to increase moderately, price tends to decrease slightly, and producer revenue tends to increase moderately. These results follow from the estimated production-enhancing effect of the WGSP.

The mean variability effects of the WGSP are: the WGSP appears to only slightly aggravate the transmission of domestic yield variability to the foreign market; at the same time, it appears to have a substantial effect on reducing the transmission of foreign demand variability to the domestic market.

Postscript

In July 1991 the WGSP was replaced by the Guaranteed Revenue Insurance Program (GRIP). The GRIP program is financed jointly by the federal government, the provincial governments, and participating producers. It is expected to be significantly more distortionary than the WGSP since it is a price-based support program rather than an aggregate net income support program as was the WGSP.

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References

Agriculture Canada. *Food and Agriculture Regional Model II: Grains and Oilseeds.* Ottawa: Agriculture Canada, March 1980.

———. *Western Grain Stabilization: Annual Report.* Communications Branch, Ottawa. Various issues.

Ahmadi-Esfahani, F. Z. "Estimation of Price Elasticities of Export Demand for Canadian and U.S. Wheat: A Nontraditional Approach." *Can. J. Agr. Econ.* 37(1989):173–90.

Bureau of Agricultural Economics. *Agricultural Policies in the European Community.* Canberra: Australian Government Publishing Service, 1985.

Capel, R. E., and L. R. Rigaux. "Analysis of Export Demand for Canadian Wheat." *Can. J. Agr. Econ.* 22(1975):1–14.

Muth, J. F. "Rational Expectations and the Theory of Price Movements." *Econometrica* 29(1961):315–35.

Organization for Economic Cooperation and Development (OECD). *Ministerial Mandate on Agricultural Trade.* Report to the OECD Ministerial Council by the Committee for Agriculture and the Trade Committee, May 1987.

Parikh, K. S., G. Fischer, K. Froehberg, and O. Gulbrandson. *Towards Free Trade in Agriculture.* Laxenburg, Austria: International Institute for Applied Systems Analysis, 1986.

Roberts, I., G. Love, H. Field, and N. Klijn. *U.S. Grain Policies and the World Market.* Canberra: Australian Bureau of Agricultural and Resource Economics, Australian Government Publishing Service, 1989.

Roningen, V. O., and P. M. Dixit. *Economic Implications of Agricultural Policy Reforms in Industrial Market Economies.* Staff Report No. AGES 89-36, Agricultural and Trade Analysis Division, Economic Research Service, U.S. Department of Agriculture, August 1989.

Spriggs, J. "Economic Analysis of the Western Grain Stabilization Program." *Can. J. Agr. Econ.* 33(1985): 209–30.

Spriggs, J., and G. C. Van Kooten. "Rationale for Government Intervention in Canadian Agriculture: A Review of Stabilization Programs." *Can. J. Agr. Econ.* 36(1988):1–21.

Tyers, R., and K. Anderson. "Imperfect Price Transmission and Implied Trade Elasticities in a Multi-Commodity World." Chapter 9 in *Elasticities in International Agricultural Trade,* eds., C. A. Carter and W. H. Gardiner. Boulder CO: Westview, 1988a.

———. "Liberalizing OECD Agricultural Policies in the Uruguay Round: Effects on Trade and Welfare." *J. Agr. Econ.* 30(1988b):197–216.