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EFFECTS OF GOVERNMENT PROGRAMS ON WHEAT ACREAGE RESPONSE IN THE U.S. AND CANADA

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Abstract

A comparative examination of the two major exporters' dynamic wheat acreage response models reveals that U.S. farmers have responded more sensitively than their Canadian counterparts to government programs but less sensitively to price. This results from differences in the methods of government intervention and possibilities for crop substitution. Direct control on acreage characterizes the U.S. approach, while the Canadian approach is one of guaranteeing minimum returns and volumes marketed through the Canadian Wheat Board. In addition, more alternative crops are available for substitution in Canada than in the U.S.

Wheat producers in both the U.S. and Canada face greater market uncertainty than producers of any other grains. The reasons for this are: (1) the percentage of exports to total production is greater for wheat than for other grains and (2) exports are largely dependent upon generally uncontrollable crop conditions in importing countries as well as in exporting countries. Because of the volatile world wheat market caused by uncertainty, government intervention in production and consumption among the major exporting and importing countries is accepted as a norm rather than an exception. Two major wheat exporting countries, the U.S. and Canada, have introduced various government programs either to control domestic production or to maintain orderly marketing for export in order to stabilize prices received by farmers. Government programs implemented for this purpose in the U.S. and Canada are substantially different from each other. It is the authors' contention that the efficacy of the respective government programs would be significantly different in terms of their impact on the farmer's decison making process for produc-

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tion.

Although differences in grain marketing systems between the U.S. and Canada have been examined (McCalla and Schmitz), a comparative examination of government intervention and its effect on wheat acreage response has been neglected up to now. The objective of this study, therefore, is to examine farmers' responses to prices and government intervention on wheat acreage planting decisions in a framework of dynamic analysis for the crop years 1961 to 1980.

Government Intervention for Wheat Acreage

In the U.S., wheat can be categorized as winter and spring wheat. The total number of winter wheat acres planted is approximately 74 percent of the total wheat acreage, and the total spring wheat acreage is about 26 percent. Spring wheat production is highly concentrated in the Northern Plains (i.e., North and South Dakota, Minnesota, and Montana). On the other hand, winter wheat is produced in the rest of the plains states. In Canada, wheat production is concentrated in the Canadian Priarie Provinces which have accounted for about 97 percent of the total acreage in the last 10 years. Winter wheat is grown only to a very limited extent in the Canadian prairies owing to the severe winter climatic conditions, while spring wheat (other than durum) is grown on about 84 percent of the total acreage planted for wheat.

The U.S. farm policy is divided into two major government programs: income support and production control. Income support programs include target prices and loan rate. Production control policy is implemented by acreage allotment, additional diversion, and set-aside programs (Cochran and Ryan).

In the 1960s, acreage allotment and diversion were mainly used to control production in the U.S. Under these programs, participating wheat producers were assinged acreage allotments which served as upper limits for their plantings. For some years, the programs offered the additional option of diverting acres below the allotments for additional payments. Participants in the programs were eligible for program benefits, use of the loan support option and receipt of diversion payments.

Under the *Agricultural Act* of 1970, the allotment program was replaced with the set-aside program for the 1971–73 crop years. Participating producers were required to withdraw cropland from production under the set-aside program. Benefits for participants included use of the loan support programs and receipt of certificate payments as compensation for the required acreage set-aside.

The diversion and set-aside programs appeared to be similar, but they were significantly different. The diversion program limited wheat allotment acreage, while the set-aside program idled acres from total cropland on the farm. Consequently, the programs had different impacts upon acres planted to wheat.

The acreage allotment program was reintroduced with deficiency payments under the *Agricultural Act* of 1973 (USDA). The program, however, was not effective during 1974–77 because wheat prices were higher than the target prices during that pericd.

Under the *Agricultural Act* of 1977, the acreage allotment program was replaced with the national acreage and farmer-owned reserve programs. The set-aside program was reintroduced in 1978–79 to reduce wheat supply. The national acreage program was similar to the acreage allotment program used during 1974–77.

In contrast to the U.S. programs, Canadian approaches were not directed toward acreage control for wheat or other grains except for the Lower Inventories for Tomorrow (LIFT) program. The LIFT program was introduced in the 1970–71 crop year but was abandoned the follwoing year. The LIFT program was designed to lower wheat inventories by paying farmers not to produce wheat.[1] As a result of the program, wheat acreage was reduced substantially in that year and the acreage was diverted largely to summer fallow. Canadian approaches are an indirect way of achieving orderly marketing through the Canadian Wheat Board (CWB).[2] The CWB has two principal functions: (1) selling and pricing grains for export and (2) efficient movement of grain to export terminals (Wilson). Under the Canadian system, prairie grain producers have two major options with respect to marketing opportunities; the off-Board feed market where the marketing quota is less restrictive, and the commercial elevator system where the marketing quota is more restrictive. The latter is normally referred to as Board grain.

With regard to the first principal function of the Board, when grain producers in the Prairie Provinces sell their grain to the CWB, they receive payments in a number of installments (initial, adjustment, interim, and

[1] The LIFT program was introduced in response to the very high level of inventory which was built up and was depressing the price of traded grains. Farmers were paid $10.00 per acre to take wheat acreage out of production and put it into summer fallow or permanent forage.

[2] The CWB, enacted by Parliament in 1935, is a crown corporation (centralized marketing authority) with monopoly control over the marketing of designated crops (e.g., wheat, barley, and oats) produced in the Prairie Provinces and the Peace River area of British Columbia. There are other government programs, however, available in Canada outside the jurisdiction of CWB. Income stabilization programs through the *Crop Insurance Act* (1959) and *Western Grain Stabilization Act* (1976) are examples. These programs may have reduced business risks on grain enterprises such that the farmers' resource allocation decision between grain activities and livestock may have been affected. These programs, however, are not included in this study since the intent of the above acts was not to influence acreage allocation decisions.

final payments) within 18 to 24 months after planting. The CWB pays producers an initial payment for grain delivered to the primary elevator companies.[3] The initial payment is essentially a floor price, since the Canadian government makes up the difference if the average selling price (finally realized) is below the initial payment. Thus, it is a government guaranteed floor price which is designed to reduce uncertainty associated with any potential price decline.[4] Such pricing practices in Canada are regarded by the farmers as having two important roles: (1) guaranteeing minimum returns and (2) easing the cash flow requirement during the crop year since final payment comes about 18 to 24 months after seeding.

The second principal function by the CWB is the Board's control over the marketing of grain through the use of the marketing quota system (i.e., grain delivery quotas applicable to Board grain). The primary objective of the delivery quota system for grain is to enable the CWB to bring into country elevators the kinds, qualities, and quantities of grain required to compete effectively for export market demand at the right time. The delivery quota system also provides for equitable allocation of delivery opportunities among producers and at the same time minimizes elevator congestion problems. The CWB has on occasion guaranteed minimum quotas for the principal grains on March 1, when the initial payments for the basic grades of grain are announced (Wilson). Therefore, the initial payments and the potential delivery quotas for wheat, oats, and barley (i.e., Board grain) are considered to be a policy instrument vis-a-vis

[3] The initial payments are made to producers on behalf of the CWB by the elevator companies receiving grain at their primary elevators. Elevator companies are not reimbursed by the Board for initial payments they have paid out until they have shipped the grain to the terminal elevators and have delivered terminal warehouse receipts to the Board. One of the reasons why only a partial advance (initial payment) is made at the time of delivery is that under a price pooling system, the full average price due to producers cannot be determined until after the bulk of the pooled grain has been sold. Should circumstances warrant an increase in the level of any initial payment during the course of a crop year, this would result in an adjustment payment (retroactive to the beginning of the crop) which is normally made in the spring of the year when it is clear that selling prices will be well above the initial payment level announced at the start of the crop year. Also, the government may authorize an interim payment after the end of a crop year, but before the results of the pool are fully known. The interim payments are again advances on the final payments and were made, for wheat, twice out of the 20 years during the time period under study. Final payments from pool accounts must await closing of the accounts. This is done after residual unsold stocks in the account are sufficiently small enough to be priced and transferred into the next pool account.

[4] The magnitude of initial payment vis-a-vis the total realized price (which is the sum of the initial, any adjustment or interim, and the final payment) has varied widely during the time period under study. The initial payments ranged from 49 percent (in the 1973–74 crop year) to 100 percent (in the 1968–69 crop year) of the total realized price.

acreage allocation among alternative crops.[5]

The Acreage Response Model

The conceptual model used in this study is Nerlove's partial adjustment model. Justification for using the partial adjustment model is based on the assumption that producers anticipate a certain level of wheat acreage desired at a given price with the continuous adjustments of the desired level to the actual acres planted as price changes (Nerlove). The adjustments are needed because the desired acres are not necessarily equal to the actual acreage planted.

Specification of annual wheat acreage response begins with the following relationship:

$$A_t^* = a_1 + a_2 p_{t-1} + \sum_{i=3}^{k} a_i x_{it} \qquad (1)$$

where A_t^* is the desired acreage in year t, p_{t-1} is price of wheat lagged one year, and X_{it} with $i = 1,2 \ldots k$ represent government policy instruments and other relevant independent variables.

Dynamic adjustments of actual acres planted to the desired acres can be expressed as

$$A_t - A_{t-1} = \delta (A_t^* - A_{t-1}) + U_t \qquad (2)$$

where δ is the coefficient of acreage adjustment with $0 < \delta < 1$, A_t is the number of acres planted in year t, and U_t is a random error term. This adjustment equation indicates that the actual change in acres planted in year t is only a fraction (δ) of the difference between desired and planted acres.

Combining equations (1) and (2) gives the first order difference equation with lagged prices as follows:

$$A_t = \delta a_1 + \delta a_2 p_{t-1} + (1 - \delta) A_{t-1} + \delta \sum_{i=3}^{k} a_i X_{it} + U_t$$

or

$$A_t = b_0 + b_1 p_{t-1} + b_2 A_{t-1} + \sum_{i=3}^{k} b_3 X_{it} + U_t \qquad (3)$$

This model is used to estimate spring and winter wheat acreage response in the United States and spring wheat acreage response in Canada.

Government policy variables used in the U.S. models are acreage allotment additional diversion, set-aside and the farmer-owned reserve programs.[6] The feed grain price index is also included in the model to

[5] The relative level of initial payments and delivery quotas for each type of grain can be adjusted by the CWB in order to guide farmers in their planting decisions towards reaching the CWB's acreage target.

[6] Price support programs (target prices and loan rates) are not included in the

capture effects of competing crops. For the Canadian model, government policy and over relevant variables (X_t) include CWB's initial payment, LIFT, CWB's wheat delivery quota and barley price.

Data for the period from 1961–1980 were used to estimate acreage response equations. In the U.S. model, prices used are season average prices received by farmers in 1967 dollars (deflated by the index of prices paid for all production items). The feed grain price index was also deflated by the index of prices paid for production items. The price data were obtained from Agricultural Statistics (USDA, 1982). Data for allotment, diversion, and set-aside acres are available for individual states but are not available by type of wheat (Wheat Situation). Therefore, allotment, diversion, and set-aside acres used for the acreage response equation for spring wheat are calculated from the major spring wheat producing states. For those states which produce both spring and winter wheat, acreage figures related to allotment, diversion, and set-aside are divided into spring and winter wheat by the proportion of spring and winter acres to total wheat acreage. In general, Minnesota, South Dakota, and Montana produce both spring and winter wheat. North Dakota is the only state in which spring wheat is virtually the only type of wheat produced. The acreages for winter wheat are calculated by subtracting the acreages for spring wheat from those for all wheat. In the Canadian model, initial and final realized prices of wheat and the farm price of barley are deflated by the index of prices paid for production items in Canada (1971 = 100). The index was obtained from the Canadian Statistical Review (Statistics Canada) while all other data were obtained from the Canadian Wheat Board's Annual Report series.

Empirical Results

It was recognized that equation (3) leads to two estimation difficulties: autocorrelated residuals and correlation of A_{t-1} with disturbance terms. It was also recognized that the error terms are correlated between U.S. spring and winter wheat acreage models while those in the Canadian wheat acreage response model are not correlated with the U.S. acreage response models.[7] Seemingly unrelated regression technique suggested by Zellner (1962) therefore was used to estimate the U.S. models. However, Zellner's

U.S. wheat models as did Garst and Miller in their study because these variables are not directly related to production control in the U.S.

[7] Wheat production activities in the U.S. and Canada are neither constrained by any policy instrument common to both countries nor correlated to net prices received by farmers (i.e., including all benefits received) in the two countries. Therefore, there is no reason to believe that error terms for the spring wheat equations for both countries are correlated. It is also empirically confirmed that the Canadian acreage response model is not correlated with the U.S. models. Thus, the econometric technique used is a single equation estimation rather than a system estimation such as the Seemingly Unrelated Regression technique.

estimator is not consistent for estimating the parameters of the seemingly unrelated regression model with lagged dependent variables and autocorrelated error terms. To overcome this problem, the estimation procedure suggested by Kmenta and Gilbert was used to estimate the U.S. models. The estimation procedure used includes the following steps: (1) use the method of instrument variable technique to obtain consistent estimates for winter and spring wheat acreage models. Using these preliminary estimates, the autocorrelation coefficients for two acreage equations are estimated, (2) use generalized differencing technique to alter equation 3 into one in which the errors are independent, and (3) finally, use generalized least squares estimator to the system of winter and spring wheat acreage equations transformed in step 2 to obtain consistent and efficient estimates of parameters in equation 3. For Canadian wheat acreage response model, an instrument variable technique (steps 1 and 2) is used to correct correlation between A_{t-1} and U_t, and autocorrelated errors.

Estimated acreage response models for winter and spring wheat in the U.S. and spring wheat in Canada are shown in Table 1. The structure of the models used in the estimation of the Canadian acreage response equation is the same as that specified in equation (3) except the variable P_{t-2} is added for Canadian spring wheat. The P_{t-2} variable is included for the Canadian wheat model because spring wheat price at t-2 often provides the latest realized price information at seeding time because of the time lag involved in receiving the final payment from the CWB.

Effects of Government Programs

Acres planted in the United States have a positive relationship with the acreage allotment program (X_1) and have a negative relationship with the additional diversion (X_2) and set-aside programs (X_3). The additional diversion program is more effective in controlling wheat acres than the set-aside program, because, while the additional diversion program restricts wheat allotment acres, the set-aside program idles acres from total cropland. Dummy variables for no allotment (X_4) and for the farmer-owned grain reserve program (X_5) shift the acreage response equation upward, indicating that the no allotment and farmer-owned reserve programs increase planted acres for winter and spring wheat.

Because of the nature of government programs and differences in production practices between winter and spring wheat in the U.S., effects of govenment programs differ between the two types of wheat. Alternative crops such as sunflower and barley could be produced in spring wheat areas, but such alternative crops do not generally exist in winter wheat regions. In addition, since winter wheat is planted in the fall, farmers have the option of declaring certain planted acres to be diversion or set-aside for the following spring. However, farmers planting spring wheat do not have such an option. Therefore, spring wheat producers are more

TABLE 1 ESTIMATED PARAMETERS OF WHEAT ACREAGE MODEL (t VALUES IN PARENTHESES)*

	United States		Canada
Variable[a]	Winter	Spring	Spring
Constant	−15.364	−17.958	−22.857
	(3.31)	(2.91)	(2.258)
P_{t-1}	3.325	2.637	32.045
	(2.22)	(2.66)	(1.965)
P_{t-2}			11.296
			(3.081)
A_{t-1}	0.313	0.502	0.654
	(5.04)	(4.52)	(6.294)
X_1	0.621	0.793	
	(8.23)	(2.20)	
X_2	−0.999	−1.009	
	(2.58)	(0.48)	
X_3	−0.406	−0.582	
	(2.04)	(1.02)	
w_4	31.466	17.905	
	(9.26)	(3.87)	
X_5	2.235	(6.644)	
	(1.19)	(3.48)	
X_6			38.045
			(2.790)
X_7			−15.205
			(6.275)
X_8			0.082
			(3.409)
X_9	16.937	9.301	
	(4.39)	(2.59)	
X_{10}			−48.615
			(2.065)
X_{11}			−43.715
			(2.964)
ρ	0.294	0.320	0.345
	(1.27)	(2.42)	(3.94)
R^2	0.979	0.939	0.961
SE	1.408	1.383	1.890

*Seemingly unrelated regression is used to estimate the U.S. spring and winter wheat acreage response models, while instrumental variable technique is used for the Canadian acreage response model.

[a] p_{t-1} = price of what by type in year t-1 deflated by the farm input price index (dollars per bushel).

P_{t-2} = price of wheat by type in year t-2 deflated by the farm input price index (dollars per bushel).

A_{t-1} = acreage of wheat by type, in million acres in year t-1.

X_1 = acreage allotment in million acres in U.S.

X_2 = addition of diversion in million acres in U.S.

X_3 = wheat set-aside acres in U.S.

X_4 = no allotment dummy variable (1 for 1971–73 for spring wheat, 1 for 1972 and 1973 for winter wheat, 0.26 for 1971, and 0 otherwise).

X_5 = dummy variable representing the farmer-owned grain reserve in U.S. (1 after 1977 and 0 otherwise).
X_6 = CWB's initial payment for wheat announced prior to seeding deflated by the farm input price index in year t multiplied by X_{11}, (i.e., initial payment multiplied by a dummy variable).
X_7 = dummy variable representing lower inventories for tomorrow (LIFT) program in Canada (1 for 1970/71 and 0 for all other years).
X_8 = a proxy variable for the CWB's wheat delivery quota in million tons.
X_9 = feed grain price index in U.S. in year t-1 deflated by the farm input price index.
X_{10} = barley price in the Canadian Prairies in year t-1 deflated by the farm input price index.
X_{11} = dummy variable representing Canadian government's policy of announcing initial payments for the basic grades of grain in the forthcoming year at March 1 (1 for 1973/74–1978/80, 0 otherwise).
ρ = coefficient of the first order autoregressive error term.
SE = standard error of estimates.

sensitive to the government program than winter wheat producers.

For Canadian spring wheat, it was hypothesized that the initial payment (X_6) for wheat announced prior to seeding did positively influence wheat acreage planting and was confirmed statistically as being significant at the 95 percent confidence level. Note that the specification of the model vis-a-vis initial payment and the definition of the variable are different from earlier studies by Meilke (1976) and MacLaren (1977). Both Meilke and MacLaren used initial payment at t-1, which included the adjustment payment, and found that it was statistically significant. The model specified in the present study, however, reflects more accurately the current policy environment in Canada, because the initial payment at time *t* has been available prior to planting since 1973.

The data for marketing quotas were not readily available for the historical series from published sources to incorporate into the time-series analysis: a proxy variable (i.e., actual wheat delivery made to the primary elevators in year t-1), therefore, was used. It was found that the proxy variable (X_8) is positively related to acreage planting, as expected, and is statistically highly significant.

Finally, the coefficient of the LIFT program variable (X_7) is highly significant and has a negative sign which indicates that wheat acreage was about 14.4 million acres smaller in 1970/71 than it would have been in the absence of the government program.

All government programs were tested simultaneously with the null hypothesis that estimated coefficients associated with government programs are equal to zero. The F-test with the sum of square errors obtained from restricted and unrestricted models was used to test the null hypothesis.[8] The calculated F-values for U.S. models indicate that government pro-

[8] The unrestricted models are the same as the equations in Table 1. The restricted models do not include all policy variables specified in the unrestricted models.

TABLE 2 SUM OF SQUARE ERRORS AND F-VALUES FOR U.S. AND CANADIAN WHEAT ACREAGE RESPONSE

	United States		Canada	
	Winter	Spring	Spring	
			1	2
SSE_{UR}	14.68	10.97	14.43	14.43
SSE_R	305.82	69.01	216.03	57.54
F-Value*	27.76	7.41	17.30	4.50

$$* F_{r,\, n-k} = \frac{(SSE_R - SSE_{UR})/r}{SSE_{UR}/n\text{-}k}$$

where SSE_R = sum of square errors in the restricted model
SSE_{UR} = sum of square errors in the unrestricted model
r = degree of freedom for the numerator
n-k = degree of freedom for the unrestricted model

1 = Test results of all government programs in Canada.
2 = Test results excluding the LIFT program.

TABLE 3 ESTIMATED PRICE ELASTICITIES

	United States		Canada
Price Elasticity	Winter	Spring	Spring
Short-Run	0.108	0.197	2.376
Long-Run	0.160	0.488	4.919

grams are significant at the 99 percent confidence level (Table 2). Regarding the Canadian model, when all government programs such as LIFT, initial payment, and marketing quota variables are included, the F-value indicates that these programs are significant at the 99 percent confidence level. However, when LIFT was excluded as a policy variable because it was not a continous program, the calculated F-value was significant at the 95 percent confidence level.

Price Effects

Wheat acreage planted is positively related to wheat price (p_{t-1}) and the feed grain price index (X_9) in winter and spring wheat response models in the U.S. The positive coefficient of the feed grain price index in the U.S. models indicates that wheat is a good substitute for feed grains for final consumption, while production replacement of wheat with feed grains is limited in wheat producing areas.

The lagged total realized prices (i.e., p_{t-1} and p_{t-2}) in the Canadian model were positively related to the wheat acreage and statistically significant as expected. Barely price (X_{10}) has a negative sign as expected *a priori* since it is an alternative crop to be planted.

As shown in Table 3, short-run and long-run price elasticities of acreage response are all inelastic in the U.S. wheat models. However, winter wheat acreage response is much more inelastic than that of spring wheat. The reason for this is that spring wheat competes with other crops such as barley and sunflower, but winter wheat does not compete with other crops. In contrast to the U.S., price elasticities in Canada are estimated to be elastic. The reasons for much higher elsticities in Canada than in the U.S. are: (1) more substitutable crops (e.g., barley, rapeseed, oats, etc.) are available in the Canadian Prairies and (2) the U.S. farm programs control wheat acres directly, while the Canadian program is price-oriented.

Conclusions

This study reveals that U.S. farmers have been responding to government programs actively during the time period under study. Production is effectively being controlled through the acreage control programs even though farmers' responses to such programs is somewhat different for winter wheat and spring wheat. In Canada, wheat acreage planting decisions have been positively influenced by policy instruments such as initial payment and delivery quota with the exception of the crop year 1970–71 when the LIFT program was implemented.

Canadian farmers have responded to market price more sensitively than their U.S. counterparts because of two reasons: (1) the Canadian approach in government intervention is more price-oriented as far as acreage allocation is concerned and (2) Canada has more alternative crops for substitution than in the U.S.

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