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Optimal Control of the Canadian Wheat Economy: A Normative Approach

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Abstract

An optimal control model based on Pontryagin's maximum principle is used to determine optimal wheat supply in Canada. The study reveals that in order to maximize the social benefits accruing to producers and domestic consumers in both Canada and importing countries, Canadian wheat prices should be higher than in the early 1980s. Optimal prices would require lower levels of wheat production and exports compared to the corresponding annual averages of the early 1980s, while in order to maximize social benefits wheat carry-over stocks would need to be much smaller.

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At least two factors, inter alia, produce continuous disequilibrium in the output and factor markets for Canadian wheat and result in less than optimum socio-economic conditions. These factors are the imbalance between supply of and demand for wheat and the impact of conditions in overseas markets.

On the supply side, rising productivity and the application of labor-saving technology have resulted in wheat production in Canada growing at a faster rate than effective demand. On the demand side, domestic consumption has been constrained by a slow rate of increase in population and by low income and price elasticities of demand. Foreign demand for wheat products has been limited by a lack of foreign exchange in food-deficit developing countries and by protectionism based on policies aimed at greater self-sufficiency in many food-importing countries. In addition, some major producing countries have made extensive use of export subsidies in seeking to penetrate the international market, thus exacerbating the situation.

The joint effect of these influences has resulted in chronic excess capacity in the world wheat economy, which has been reflected in a deterioration in the terms of trade. Consequently, from time to time, food-deficit countries of the world have been able to buy wheat at less than its fair value and to accumulate wheat surpluses to act as a cushion against fluctuations in world output. Thus, farmers and taxpayers in exporting countries have had to carry a large share of the costs of adjusting to global imbalances between output and effective demand, and the incomes of wheat producers have not risen proportionally with rising productivity. This has been especially true in Canada because wheat is the most important agricultural export. Consequently, an adequate policy for managing the supply of wheat is urgently needed if social benefits to both Canadian producers and foreign buyers are to be improved.

The purpose of this paper, therefore, is to attempt to determine the long-run optimal paths of wheat production, consumption, carryover, and price. An econometric model has been developed consisting of the following equations: supply, domestic demand, export, carryover, and price. In addition, an optimal control model based on Pontryagin's maximum principle has been used to determine optimal wheat production.

A brief review of the literature indicates that in recent years several researchers have used the technique of optimal control theory based on Pontryagin's maximum principle (or Bellman's equation) to analyze economic policies. Much of the initial work in this area was done by Shell; Arrow and Kurz; Chow; and Pindyck. The optimal control model was also extended to determine optimal carryover stocks (Gustafson; Burt _et al_.; Koo and Burt; and Taylor and Talpaz). The method used by Gustafson, Burt _et al_., and Koo and Burt was a stochastic dynamic optimization technique based on the Markov decision process, and that used by Taylor and Talpaz was a certainty equivalence method. More recently, Chow's stochastic control formulations have been used to discuss optimal agricultural policies in the United States, such as those pertaining to support prices and exports (Arzac; Arzac and Wilkinson).

Government Intervention in the Wheat Market

In recent decades, Canadian farm programs for the stabilization of the wheat economy have not been directed toward acreage control except for the Lower Inventories for Tomorrow (LIFT) program, which was designed to lower wheat inventories in that farmers were paid not to produce the crop.[1] The LIFT program was introduced in crop year 1970/71 but was abandoned the following year. As a result of the program, wheat acreage was reduced substantially, with land being diverted largely to summer fallow. Less directly, the wheat acreage has been influenced by the operation of the Canadian Wheat Board (CWB) in its capacity as the centralized marketing authority for cereal crops. The CWB, established by Parliament in 1935, is a crown corporation with monopoly control over the disposal of designated crops (especially, 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 the CWB. Income stabilization measures effected through the *Crop Insurance Act* (1959) and the *Western Grain Stabilization Act* (1976) are examples. These measures may have influenced farmers' resource-allocation decisions between grain activities and livestock husbandry; they have not, however, been included in the purview of the present study since the intent of the enabling legislation was not to influence acreage allocation decisions.

The CWB has two principal functions: (i) the selling (including pricing) of grains for export; and (ii) the efficient movement of grains to export terminals. Under the CWB system, Prairie grain producers have two major outlets with respect to marketing opportunities: the commercial elevator system, where the marketing quota tends to be restrictive, and the off-Board feed market, where sales are less constrained. Products passing through the elevator system are normally referred to as Board grain.

When producers in the Prairie provinces sell their grain to the CWB, they receive payments in a number of installments (initial, adjustment, interim, and final) within 18 to 24 months after planting. The initial payment for grain delivered to the primary elevator companies[2] is essentially a floor price, since the Canadian government makes up any difference between this and a lower average realized price. Thus, it is a government guaranteed minimum price designed to reduce uncertainty associated with any potential price decline.[3] Such pricing practices in Canada are regarded by the farmers as serving two important roles: (i) guaranteeing minimum returns; and (ii) easing cash flow requirements during the crop year as final payments are made about 18 to 24 months after seeding. Further, it will be apparent that initial payment may be used by the CWB as a policy instrument to influence acreage allocation among alternative crops.[4]

Estimation of Empirical Relationships

The wheat supply response equation is estimated on the basis of time series data for the crop years 1960/61 to 1981/82. Specification of the supply model was based on Nerlove's partial adjustment hypothesis. The estimated model is shown as follows:

$$A_t = -22.857 + \underset{(4.981)}{32.045P_{wt-1}} + \underset{(2.790)}{38.045X_{1t}} - \underset{(6.275)}{15.205X_{2t}} \tag{1}$$

$$+ \underset{(3.409)}{0.082X_{3t}} - \underset{(2.065)}{48.615P_{bt-1}} - \underset{(2.964)}{43.715D_t} + \underset{(5.040)}{0.41A_{t-1}} + e_t$$

$$e_t = 0.345\ e_{t-1} + V_t$$

$$R^2 = 0.961$$

$$SE = 1.890$$

where A_t is the wheat acres planted in time t in Canada, X_{1t} is the initial payment announced by the Canadian Wheat Board (CWB), X_{2t} is the dummy variable representing lower inventory for tomorrow (LIFT), X_{3t} is a proxy variable representing the CWB's wheat delivery quota, P_{wt-1} is the wheat price received by farmers in time t-1, P_{bt-1} is the barley price received by farmers in time t-1 and D_t is a dummy variable representing the Canadian government's policy of announcing on March 1 initial payments for the basic grades of grain in the forthcoming year (1 for 1973/74 to 1980/81 and 0 for other years). All prices have been deflated by the farm input price index (1981=100). The numbers in parentheses are the t-values.

The estimated acreage response equation is multiplied by the last five years' average wheat yield per acre to calculate the supply response equation. The supply equation is further revised by eliminating dummy variables representing LIFT (X_{2t}) and representing the Canadian government policy of announcing initial payment (D_t) under the assumption that Canada will maintain the current program in the near future and by adjusting the intercept term of the equation with X_{3t} and P_{bt-1} at their sample means. The revised supply equation is:

$$Q_t = -41400 + 308.53P_{wt-1} + 470X_{1t} + 0.41Q_{t-1} \quad (2)$$

where Q_t is the quantity of wheat produced in time t-1.

Domestic demand for wheat is mainly for industrial use for food and farm use for feed and seed. Specification of the domestic demand equations for wheat is based on Nerlove's partial adjustment hypothesis. The estimated demand for commercial use (CD) and farm use (FD) for crop years from 1960/61 to 1980/81 are as follows:

$$CD_t = 1949.5 - 3.16P_t + 29.23TR + 339.12D_t + 0.265CD_{t-1} \quad (3)$$
$$(2.22) \quad (2.67) \quad (2.28) \quad (1.41)$$

$R^2 = 0.841$

$$FD_t = 2082.2 - 0.82P_{dt} + 194.82D_t - 429.1D_{1t} + 0.19FD_{t-1} \quad (4)$$
$$(2.01) \quad (2.34) \quad (2.68) \quad (0.93)$$

$R^2 = 0.58$

where P_t is the price of wheat at Thunder Bay, TR is the time trend, D_t is the dummy variable representing the large wheat import from the USSR in 1973, P_{dt} is the domestic price of wheat, and D_{1t} is a dummy variable representing domestic wheat policy. All prices were deflated by the consumer price index (1981=100). Conversion of the domestic price of wheat (P_{dt}) in Equation 4 into the wheat price at Thunder Bay (P_t) was performed by using the empirical price relationship between P_{dt} and P_t estimated for this study. Then equations 3 and 4 were aggregated for total domestic wheat consumption in order to use this equation in the optimal control model. The aggregate demand model is as follows:

$$D_t = 6171.4 - 3.97\ P_t \quad (5)$$

where D_t is the domestic demand for total wheat consumption.

The aggregate import demand equation for Canadian wheat (E_t) estimated on the basis of the partial adjustment hypothesis is:

$$E_t = 30421.7 - 42.03P_t + 3483.5D_t + 0.43ED_{t-1} \quad (6)$$
$$(1.16) \quad (1.13) \quad (1.78)$$

$R^2 = 0.387$

The estimated equation has low t-values and R^2, which indicates high volatility in Canadian wheat exports.

The Discrete Optimal Control Model

The method used for this study is an optimal control model based on the maximum principle introduced by Pontryagin. The model has one control variable and one state variable. The model is developed on the basis of a discrete time--as opposed to a continuous time--domain because wheat is produced once a year while consumed continuously over time based on earlier work by Meilke (1976), CWB's initial payment is used as the control variable. This variable has been used as a policy instrument to stabilize farm income and to control wheat production in Canada for the last few decades. The state variable is the season average wheat price at Thunder Bay. The optimal control model is developed on the basis of the equation for the supply of, domestic demand for, and foreign import demand for Canadian wheat under the assumptions that production, exports, and consumption in other exporting countries, such as the United States, Australia, and Argentina, are exogeneous. Relaxation of the assumptions alters the magnitude of the optimum values of these variables but, because of the underlying criterion of the model, does not affect the direction of change.

The criterion is to maximize the sum of the domestic consumers' surplus, the domestic producers' surplus, and the foreign consumers' surplus, minus storage costs. In Figure 1(a), DD' represents the domestic demand for Canadian wheat, while SS' represents the domestic supply, and MM' depicts aggregate foreign import demand. Domestic consumers' surplus and domestic producers' surplus, at the given world wheat price, p, are represented in

Figure 1(a) by areas hdp and egop. Foreign consumers' surplus at the given world wheat price, p, is equal to area bcp in Figure 1(b). The domestic producers' and consumers' surplus are equal to the sum of consumers' surplus (area hdp), domestic revenue (area dpok), and export revenue (area enkd) minus production costs (area eng) in Figure 1(a). The domestic surplus, therefore, is interpreted as the net social benefits given to producers and consumers in Canada.

The criterion function is expressed as:

$$W(P(t), X(t)) = PS(P(t), X(t)) + DS(P(t)) + FS(P(t)) - s\ C(t+1) \quad (7)$$

$$\text{and } C(t+1) = Q(t) + C(t) - D(t) - E(t)$$

where W(P(t), X(t)) is net world welfare; PS(P(t), X(t)) is domestic producers' surplus; DS(P(t)) is the domestic consumers' surplus; FS(P(t)) is the foreign consumers' surplus; s is the unit storage cost; and C(t+1) is the carryover stock, which is the total domestic supply (Q(t) + C(t)) minus the total demand (D(t) + E(t)). PS(P(t), X(t)), DS(P(t)) and FS(P(t)) are calculated from Equations 2, 5, and 6, respectively, as follows:

$$PS(P(t), X(t)) = \int_{o}^{P} Q_t \, dP(t) \quad (8)$$

$$DS\ (P(t)) = \int_{P}^{P_1^*} D_t dP(t) \quad (9)$$

$$FS\ (P(t)) = \int_{P}^{P_2^*} E_t dP(t) \quad (10)$$

where Q_t, D_t, and E_t are domestic supply of (Equation 2), domestic demand for (Equation 5), and foreign import demand for Canadian wheat (Equation 6), respectively. P_1^* and P_2^* are intercept points for domestic demand (DD') on the price axis (Figure 1(a)), and for foreign import demand (MM') on the price axis (Figure 1(b)), respectively.

Since the optimal control model uniquely determines numerical levels of P(t) and X(t), which maximize the net world welfare over the planning time period, the criterion should be expressed as:

$$TW(P(t),\ X(t)) = \sum_{t=1}^{T} \beta^t W(P(t),\ X(t)) \tag{11}$$

where β is the discount factor with $0 < \beta < 1$.

The criterion function is subject to the following dynamic price equation:

$$P(t) - P(t-1) = G(X(t),\ P(t),t) \tag{12}$$

where

$$G\ (X(t),\ P(t),\ t) = \alpha(Q_t + C_{t-1} - D_t - E_t) \tag{13}$$

where α is an adjustment coefficient for price. Equation 12 indicates that P(t) is equal to P(t-1) if total supply $(Q_t + C_{t-1})$ is equal to total demand $(D_t + E_t)$, and P_t is higher (lower) than P(t-1) if the total supply is smaller (larger) than total demand.

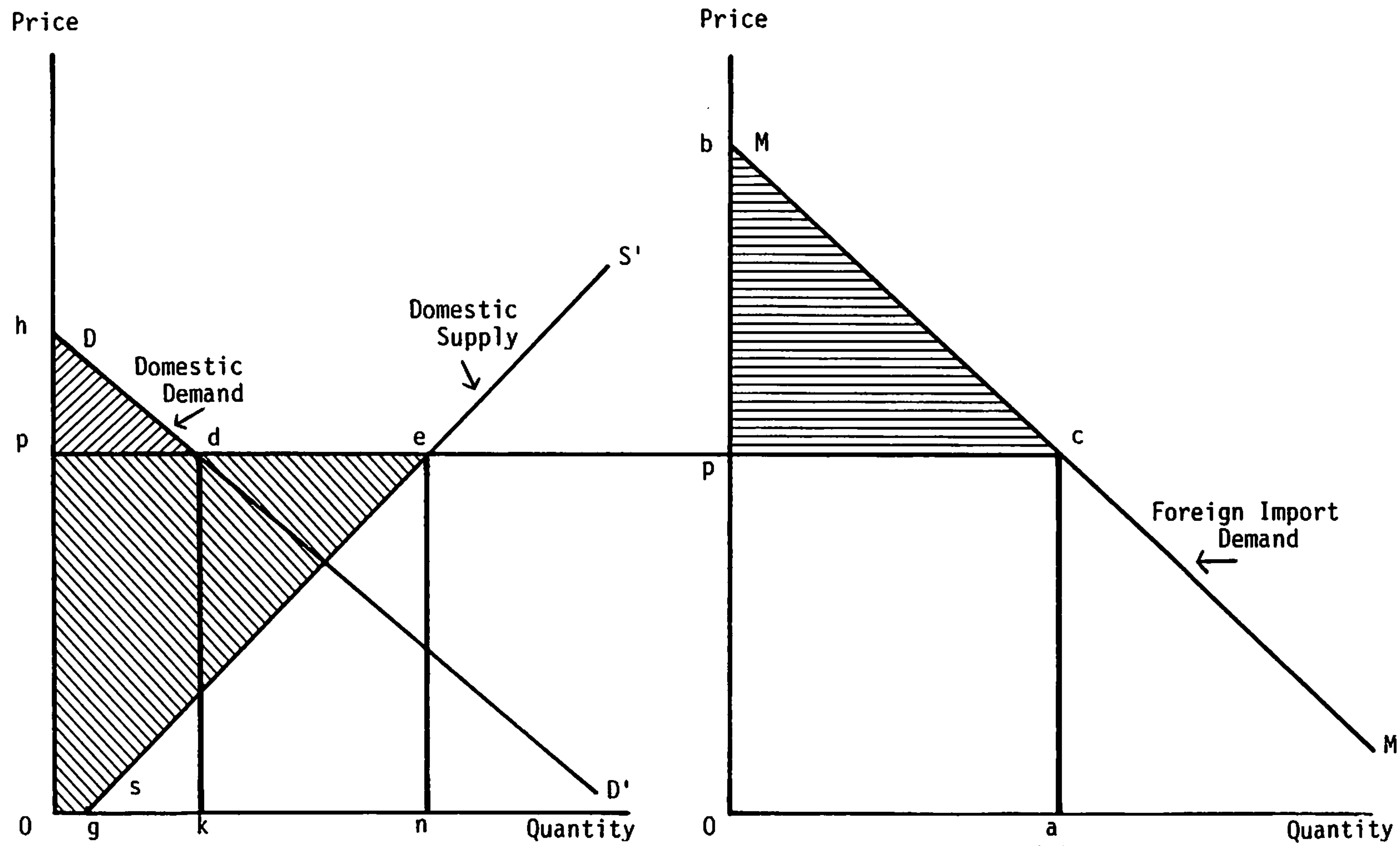
The η is the estimated excess supply elasticity, while $\bar{P}$ and $\bar{C}$ denote mean price and mean quantity of excess supply (carryover stocks), respectively. Then the term α, which is the slope of the excess supply curve, is given by

$$\alpha \approx \bar{P}/(\eta \cdot \bar{C}) \tag{14}$$

Combining Equations 11 and 12 yields the Hamiltonian equation as follows:

$$H[X(t),\ P(t)\ \lambda(t),\ t] = \beta^t\ [W(P(t),\ X(t)] - \lambda_t G[X(t),\ P(t),\ t] \tag{15}$$

where λ_t is a co-state variable or a shadow price associated with the



(a) Canadian Market

(b) Foreign Market

Figure 1. Demand and Supply of Canadian Wheat

constraint (12) and other variables are as previously defined. The necessary conditions to maximize the Hamiltonian equation are:

$$\frac{\partial H}{\partial X(t)} = 0 \qquad (16)$$

$$-\frac{\partial H}{\partial P(t)} = \lambda(t+1) - \lambda(t) \qquad (17)$$

$$\frac{\partial H}{\partial \lambda(t)} = P(t+1) - P(t) \qquad (18)$$

$$\frac{\partial G(T)}{\partial P(T)} = \lambda(T) - \lambda(T-1) \qquad (19)$$

where T indicates the index for time at the end point, G(T) is the final function or salvation value at the end point time T, P_T is price at time T, and λ_T is a value of co-state variable λ at time T.

Equations 17 and 18 represent the first-order difference equations, which are defined as the canonical state equations. Equation 16 gives the relation for optimal control of variable X_t, and Equation 19 gives the transversability condition, which should be used when P(T) is not fixed. In this particular case, G(T) is undefined; therefore, the corresponding transversability condition is not applied. The sufficient condition is satisfied since the Hamiltonian equation is linear in the control variable.

Equations 11, 17, and 18 are solved simultaneously for X(t), P(t) and $\lambda(t)$ for t = 1, . . ., T with an iterative computational method. The system is stable and converges to the long-run equilibrium condition after the twentieth iteration.

Empirical Results

Variable costs of storage are taken as $4.4 per tonne annually, and a discount rate of 6 percent is used to calculate present values. Wheat production (24.8 million tonnes), carryover stocks (9.8 million tonnes), domestic consumption (5.2 million tonnes), exports (18.0 million tonnes), and export price of wheat at Thunder Bay ($208.77 per tonne) in 1982 are used as initial conditions for the model.

For the purpose of policy analysis, in a normative sense, the following three alternative scenarios were chosen: high export, baseline export, and low export. Optimal paths of production, price, carryover stocks, domestic consumption, and exports based on the baseline scenario are compared with those in high- and low-export scenarios.

Optimal Control under Baseline Scenarios:

Table 1 presents the estimated optimal export price of wheat, initial payment, production, consumption, and carryover stocks under the baseline scenario. According to the model, the optimal wheat price in 1983 was $209.70 per tonne in 1981 Canadian dollars ($230.60 per tonne in 1983 nominal dollars), which is about 14 per-cent higher than the actual average wheat price in the same year (Table 4). Optimal exports (17 million tonnes) and production (19 million tonnes) are much smaller than actual exports (21 million tonnes) and production (26.7 million tonnes) in 1983, as shown in Table 4. This indicates that the export price of wheat should be higher than the actual export price in order to maximize social benefits for producers and consumers and that this optimal price could be accomplished by reducing exports and production.

The estimated optimal domestic consumption in 1983 is 5.3 million tonnes, which turns out to be close to actual domestic consumption in the same year. Changes in supply and demand result in optimal carryover stocks lower than actual stocks. In the long run, ceteris paribus, production, domestic consumption, exports, and carryover stocks would be stabilized at 22.1 million, 5.2 million, 16.9 million, and 6.2 million tonnes, respectively. Optimal wheat prices in the long run would be $220.80 per tonne in 1981 Canadian dollars and $242.90 per tonne in 1983 Canadian dollars. It should be noted that the estimated long-run production, domestic consumption, exports, and carryover stocks are smaller than their respective actual averages in the early 1980s, while the long-run optimal price is higher. This again indicates that, ceteris paribus, wheat production and exports in Canada should have been reduced to maximize social benefits of domestic producers and those of both domestic and foreign consumers.

It is generally true that the actual production, exports, and carryover stocks in Canada, up to 1984, were higher than the corresponding optimal levels, and this led to actual prices being lower than the long-run optimal prices. Since 1985, however, Canadian production, exports, and carryover stocks were, in general, lower than in previous years, while exports and production in particular were at almost the same levels, close to the estimated optimal. Nevertheless, in real terms, the actual price level since 1985 has dropped further from the 1983 and 1984 periods, resulting in a larger negative actual-optimal price difference. The reasons for lower actual prices since 1985 are as follows: first, world trade volumes have decreased due to larger outputs in some major wheat importing nations (e.g., USSR, China, Poland, and

Brazil) and price-depressing stocks of wheat have continued to build on the world market; secondly, in 1986, trading of wheat as a feed grain increased significantly and this contributed to lower average wheat prices on the world market; and finally, 1985/86 will be remembered as the year in which the United States and EEC, using export subsidies, entered into an all-out trade war in grain. The United States through its Export Enhancement Program (EEP), and the EEC, through its Export Restitutions, attempted to regain market share at the expense of each other and, at times, of other major exporters including Canada.

Optimal Control Under High-Export and Low-Export Scenarios:

The low-export scenario provides for a lower level of wheat exports than in the baseline scenario, resulting in a higher optimal wheat price ($218.70 per tonne in 1981 Canadian dollars) in 1983. *Ceteris paribus*, this price would tend to increase wheat production in Canada, but optimal wheat production could, in fact, be reduced by a lowering of initial payments. Because of the same underlying assumptions, the baseline and lower-export scenarios have similar optimal levels of production, exports and domestic consumption in 1983, but in the long run there would be substantial differences between the two scenarios.

Under the low-export scenario, optimal wheat price in the long run is reached at $277 per tonne, which is about 26 percent higher than in the baseline scenario. In the long run, production, domestic consumption, and exports are lower than in the baseline scenario while carryover stocks are higher. Production is reduced by lowering initial payments from $155 per tonne to $113 per tonne.

On the other hand, under the high-export scenario wheat exports are 7.6 percent higher and wheat prices are 13.6 percent lower than in the baseline scenario. Thus, the price flexibility of exports is 1.80. However, wheat price, production, domestic consumption, export, and carryover stocks in the high export scenario are the same as in the baseline scenario for 1983 and 1984 because of the same underlying assumptions. As expected, the high-export scenario requires larger production than in the baseline scenario. Optimal production is increased by raising initial payments from $155 per tonne to $176 per tonne.

Benefit Distribution and Sensitivity Analysis:

An important consideration in formulating farm programs, in the context of normative economic policy in particular, is the distribution of benefits. In the framework of Canadian production and export control, net benefits can be partitioned into components associated with domestic consumers, foreign consumers, and domestic producers. Export scenarios employed in this analysis (base, high-export, low-export) are evaluated in terms of social benefits associated with domestic consumers, foreign consumers, and domestic producers. Results of the distribution of benefits under alternative scenarios are given in Table 5. Domestic producers' benefits are largest with the low-export senario, and smallest with the high-export scenario. Producers' benefits are smallest with the actually realized export and production control in the early 1980s. On the other hand, domestic and foreign consumers' benefits are largest with the actually realized production and export and smallest with the low-export scenario. The estimated domestic producers' benefits under the low-export scenario would be $14 billion per annum larger than the benefits under actual conditions in the early 1980s. At the same time, the low-export scenario would reduce domestic and foreign consumers' benefits by over $1 billion annually compared with actual benefits. The low-export scenario generates an annual total benefit of $48 billion, which is largest among the different scenarios and larger than the total benefits obtainable under current production and export conditions in Canada. This implies that Canada should reduce its production and export of wheat below the actual levels in order to maximize its benefits; in this instance, decreases in domestic and foreign consumers' benefits would be significantly outweighed by an increase in producer's benefits.

Concluding Remarks

This study, based on a normative policy analysis, reveals the optimal time path of wheat price, production, domestic consumption, exports, and carryover stocks under three different policy scenarios: baseline, low-export, and high-export. The baseline scenario indicates that in order to maximize the aggregate social benefits of producers and of consumers in both Canada and importing countries, wheat prices in Canada should be higher than actual prices in the early 1980s. Ceteris paribus, the achievement of optimal prices would be obtained by reducing wheat production and exports compared to the early 1980s (i.e., through the implementation of the low-export scenario). This study also indicates that wheat carryover stocks should be much smaller than they were in the early 1980s in order to maximize social benefits.

Under the high-export and low-export scenarios which are postulated in the context of possible alternative government policies, an inverse relationship is demonstrated between wheat prices and exports depending upon the price elasticity of aggregate import demand for Canadian wheat. It emerges that substantial increases in wheat exports would be accomplished by a lowering of wheat prices and vice versa. Under these policy scenarios, production would be effectively controlled through initial payments made to reduce storage costs and increase social benefits.

Finally, it should be recognized that wheat prices are basically determined by underlying supply and demand conditions in the world market and cannot be controlled by unilateral decisions in Canada. Wheat production and exports at the same time cannot be isolated from international politics, and major wheat exporters, including Canada, will need to pursue more cooperative policies in order to stabilize production and optimize social benefits. In this regard, a foremost objective should be the elimination, through GATT, of the trade-distorting subsidies which have been a primary source of the depression in world wheat prices since the mid-1980s.

TABLE 1. OPTIMAL WHEAT PRICE, INITIAL PAYMENT, PRODUCTION, CONSUMPTION, AND CARRYOVER STOCKS UNDER THE BASELINE SCENARIO

Year	Price*	Initial Payment*	Production	Domestic Consumption	Exports	Carryover Stocks
	---- $/tonne ----		---------------- '000 tonnes ----------------			
1983	209.7	141.3	19,526	5,259	17,234	6,793
1984	198.2	196.8	23,542	5,305	17,717	4,313
1985	211.6	147.4	20,099	5,251	17,153	5,009
1986	207.3	175.5	24,252	5,269	17,338	6,656
1987	214.3	152.9	21,228	5,240	17,043	5,600
1988	212.9	165.4	23,119	5,246	17,099	6,375
1989	216.7	154.5	21,690	5,230	16,938	5,895
1990	216.6	159.8	22,542	5,231	16,944	6,262
Long Run	220.8	154.6	22,068	5,214	16,768	6,214

*1981 Canadian dollars.

TABLE 2. OPTIMAL WHEAT PRICE, INITIAL PAYMENT, PRODUCTION, CONSUMPTION, AND CARRYOVER STOCKS UNDER THE LOW-EXPORT SCENARIO

Year	Price*	Initial Payment*	Production	Domestic Consumption	Exports	Carryover Stocks
	---- $/tonne ----		---------------- '000 tonnes ----------------			
1983	218.7	148.1	17,527	5,222	16,854	5,209
1984	216.6	141.6	23,668	5,231	16,946	6,700
1985	236.8	186.5	19,177	5,150	16,097	5,631
1986	238.9	133.2	22,817	5,141	16,006	7,300
1987	250.9	154.6	19,678	5,093	15,499	6,385
1988	254.3	128.5	21,253	5,080	15,362	1,796
1989	261.8	136.5	19,704	5,050	15,046	6,804
1990	264.9	122.8	20,353	3,037	14,913	7,207
Long Run	277.2	112.9	19,557	4,988	14,399	7,368

*1981 Canadian dollars.

TABLE 3. OPTIMAL WHEAT PRICE, INITIAL PAYMENT, PRODUCTION, CONSUMPTION, AND CARRYOVER STOCKS UNDER THE HIGH-EXPORT SCENARIO

Year	Price*	Initial Payment*	Production	Domestic Consumption	Exports	Carryover Stocks
	---- $/tonne ----		---------------- '000 tonnes ----------------			
1983	209.7	141.3	19,526	5,259	17,234	6,378
1984	198.0	196.8	23,541	5,305	17,717	4,313
1985	206.4	165.7	22,073	5,272	17,375	3,739
1986	203.3	151.6	21,619	5,284	17,503	5,283
1987	193.7	175.0	23,833	5,323	17,906	5,887
1988	190.3	170.6	22,811	5,336	18,048	5,313
1989	191.1	175.7	22,966	5,333	18,017	4,929
1990	193.3	175.7	23,116	5,325	17,924	4,796
Long Run	190.7	175.7	23,094	5,335	18,034	4,885

*1981 Canadian dollars.

TABLE 4. ACTUAL WHEAT PRICE, INITIAL PAYMENT, PRODUCTION, CONSUMPTION AND CARRYOVER STOCKS IN CANADA, 1983-1986

Year	Price*	Initial Payment*	Production	Domestic Consumption	Exports	Carryover Stocks
	---- $/tonne ----		---------------- '000 tonnes ----------------			
1983	184.4	167.3	26,737	5,098	21,367	9,983
1984	181.9	159.4	26,505	5,533	21,764	9,190
1985	174.8	159.4	21,199	5,208	17,540	7,598
1986	147.6	147.6	24,252	5,687	17,691	8,472

*1981 Canadian dollars.

TABLE 5. DISTRIBUTION OF AVERAGE BENEFITS[a] UNDER ALTERNATIVE SCENARIOS

Scenarios	Domestic Producers	Domestic Consumers	Foreign Consumers	Total
	$ million per annum			
Base	34,976	91	9,874	44,942
Low-export	38,887	74	9,092	48,053
High-export	34,116	93	9,964	44,174
Actual[b]	25,337	123	11,240	36,701

[a]Four-year average from 1983 to 1986.
[b]Wheat price, production, consumption, and export from 1983 to 1986.

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Footnotes

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

2. The initial payments are made to producers on behalf of the CWB by the elevator companies receiving grain at their primary elevators. The elevator companies are reimbursed for these payments after the grain has been shipped to the terminal elevators and the terminal warehouse receipts have been submitted to the Board. One of the reasons why only a partial advance (i.e., the initial payment) is made at the time of delivery is the inability under a price pooling system to determine the full average price due to producers 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 year). Adjustments are normally made in the spring of the year, when it can be determined whether 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 additional advances on the final settlements, and in the case of wheat, have been made 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 small enough to be priced and transferred into the next pool account.

3. The magnitude of the initial payment vis-a-vis the total realized price (i.e., the latter being the sum of the initial payment plus interim and final payments) has varied widely during the time period under study. The initial payments ranged from 49 percent of the total realized price (in the 1973/74 crop year) to 100 percent (in the 1968/69 crop year).

4. 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.