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THE EFFECTS OF TRADE LIBERALIZATIN ON THE CANADIAN DIARY AND POULTRY SECTORS[1]

(Working Paper 3/90)

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FOREWORD

During the 1960's and 1970's Canada developed a national policy framework centred on supply management to support and stabilize the industrial milk and poultry sectors. To make supply management work imports must be strictly controlled at the border as it is through limiting supplies that domestic producer prices are maintained at an accepted level. However, supply management prevents producers from responding to prices as they would in an uncontrolled environment. This means the normal relationships used in economic analysis to predict producer response to different market situations is not readily available.

In the current round of GATT multilateral trade negotiations, liberalizing agricultural trade is a priority issue. Some proposals that have been tabled could affect supply management as now used in Canada. Decision makers and trade negotiators need to know what the impacts from proposed changes would be on these sectors. This Working Paper reports on research findings where a methodology is developed and adopted to investigate how Canadian supply managed industries might respond to complete trade liberalization. Although complete liberalization is an unlikely outcome, it does provide a useful benchmark against which to compare partial liberalization proposals, and an extreme situation against which to evaluate the methodology proposed in this study.

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ABSTRACT

Under the General Agreement on Tariffs and Trade, countries are examining proposals that would change trading rules for their agricultural sector. There is pressure to dismantle many current government agricultural support programs. This study examines an extreme position of complete trade liberalization for OECD countries and measures some of the impacts of such a change upon producers' earnings for the major agricultural commodity groups in Canada. Particular attention is directed to the dairy and poultry sectors where a methodology is proposed, and used, which examines changes in these sectors as one moves to a free trade position.

Roningen and Dixit (1988) have provided information on how government intervention in agriculture has affected world commodity markets and prices. They report that with an elimination of all subsidies to agriculture in the industrialized market economies, world production levels would fall and world prices would, on average, increase by 19 percent. Expected price changes for Canadian farmers under this trade liberalization scenario are also reported by them.

The market price changes reported are incorporated into the Canadian Regional Agricultural Model (CRAM) model for analysis of their impacts. Net sector earnings of dairy farmers increase by

34%, those of poultry producers increase by 3%, beef producers' earnings increase by 8%, and hog producers gain by 5%. The crop sector alone loses. Net sector returns to producers fall by 10%.

Producers are generally better off under this trade scenario. In the base year (1986) net sector earnings for these five commodity groups are estimated at $9.5 billion. Under the free trade scenario they are estimated at $10.2 billion. Hence, the net change to producer net earnings is $0.7 billion. In addition, significant budget savings by taxpayers may be expected because all direct and indirect financial transfer payments to producers from both federal and provincial governments are eliminated.

Two critical factors determine the exact size and direction of these changes. Firstly, the relative levels of the exogeneous world product prices, and secondly, the differences between current supply prices for producers in the supply controlled industries in each of the provinces and these new world product prices. Further attention needs to be given to these aspects of the study.

SECTION 1

INTRODUCTION

Canada is playing a major role in discussions and background studies that have committed governments in various countries to examining means of reducing the level of assistance to their farm sectors. Currently, Canada and 94 other countries are participating in the eighth round of multilateral trade negotiations (MTN) under the General Agreement on Tariffs and Trade (GATT) organization. The aim of the GATT negotiations is "the substantial reduction of tariffs and other barriers to trade" (Warley, 1987). Canada, as a major agricultural exporting nation, expects to benefit from these efforts.

Before countries around the world negotiate reform of their domestic and related trade policies, it is essential that proposed changes, both national and international, be examined for their impacts. Policy changes must be examined in terms of changes that are expected in national production levels, consumption, trade, farm incomes, asset values and more broadly in terms of their impacts on international markets.

This study examines an extreme position of complete trade liberalization and attempts to measure some of the changes upon producer earnings by sector and by province for Canada. Particular attention is directed to the dairy and poultry sectors where a methodology is proposed, and used, which examines changes in these sectors as they move to a free trade position.

The study is exploratory in nature because information on production quota values that are critical to this analysis is sparce. Quota values are used indirectly to derive the supply price (marginal cost of production) for milk and poultry products and then changes in these industries are examined as one asks the question: What would happen if quota (production) controls are removed and producers in these industries face prices established in international markets?

1.1. Background

Current MTN negotiations involve a number of proposals that would substantially reduce current levels of support to agriculture. The U.S. has called for a progressive reduction of trade-distorting agricultural subsidies. The Cairns group and others have called for a more gradual reliance on market forces and less dependence on government support. The European Community, on the other hand, calls for a long-term balancing of support across commodities and countries through a harmonization of agricultural policies, while the Japanese regard the problem of low world prices and excess supplies as being a problem for exporters. In spite of these different policy positions, there is agreement that domestic policies of many national governments have resulted in surpluses, depressed world commodity prices and contributed to burdensome government budget deficits. The solution is seen in GATT and it is expected that fairly substantial changes in world trading regimes will result. These changes need to be measured on a commodity by commodity and country by country basis.

The fundamental question of importance to Canadian federal and provincial policy makers is what changes can be expected in Canada if price and support programs are dismantled multilaterally. The Canadian Regional Agricultural Model (CRAM) has been chosen to study this issue. CRAM is a comparative static, partial equilibrium, multicommodity, multiregion linear programming model. The model represents Canada's agricultural sector with 29 crop regions producing wheat (4 grades), barley (including other coarse grains), flax, canola, corn, soybeans, hay, pasture and other crops. Livestock production is modelled at the provincial level for beef, hogs, dairy and poultry. Shipments of livestock, livestock products and grains occur to meet provincial demand levels, with excess domestic demand or supply being met by import or export activities. Demand for beef, pork and grains is endogenized using stepped functions. Opening inventories of livestock herds and poultry flocks are adjusted through incorportion of retention functions responding to own price and feed grain price effects. Trade in red meats, grains, dairy and poultry products requires that export and import prices be established; a domestic floor and ceiling price is specified. A small country assumption is adopted which means that Canadian trade will not affect world prices.

CRAM has been further modified in this study to help analyze the questions outlined above with particular attention being given to the dairy and poultry sectors. The methodology adopted to deal with the impacts of trade liberalization on supply controlled industries is detailed here. This model is also unique in that econometrically estimated supply elasticities have been incorporated into the supply blocks for livestock in a linear programming model.

1.2 Objectives of the Study

The broad objective of this study is to examine Canadian agricultural price and production changes under trade liberalization with special attention given to the supply management industries.

In order to achieve this broad objective the following subobjectives are listed:

1.1 To review theory for estimating supply functions in industries where supply management schemes are found.

1.2 To develop an empirical approach that will enable estimation of supply parameters for supply managed commodities in Canada on a province by province basis.

1.3 To incorporate econometrically estimated provincial supply and demand relationships for the dairy (industrial and fluid), egg, chicken and turkey sectors into the Canadian Regional Agricultural Model

1.4 To respecify CRAM's structure to allow for interprovincial and international trade movements of farm level products in the case of the poultry sector and manufactured products in the case of the dairy sector.

1.3 Research Procedure

In industries where production quotas exist it is possible to estimate a supply function provided a random sample of observations on output levels, input costs, output prices and a rental market for quotas exist (Moschini, 1988a). Since the rental market for quotas is extremely thin, or prohibited, an alternative approach using information on the capital values of quotes in each of the provinces is followed. Hence, given the asset values of quotas it becomes possible to estimate the difference between the administered price for a commodity and the marginal costs of production assuming a given discount rate. The procedure followed is detailed in the next section of this report, and in the Appendix.

The procedure developed to incoporate demand and supply relationships for supply controlled industries into CRAM follows the procedures reported in an earlier study by Webber, Graham and MacGregor (1988). In that study investment and disinvestment decisions of producers in the beef and hog sectors were examined and a methodology developed which allowed opening and closing livestock numbers to be a function of econometrically estimated response relationships. The same basic procedure is followed in this study in the case of the dairy and poultry sectors. Once the positions of producers on their supply functions is established one is then able to estimate their reponses to profit level or product price changes as a result of the removal of the production controls under a free trade regime.

The CRAM model traces production for all major commodities in Canada to both the domestic and international market places. In the case of the dairy sector, milk and farm separated cream supplied by dairy farmers is processed into many different dairy products and by-products. Butter, cheese and skim-milk powder are traded in international commodity markets. The CRAM model was modified in this study to allow for a dairy processing sector in each of the provinces. Supplies by province are traced to demands and any excesses are traded through shipments on an interprovincial or international basis. The work by Short and Côtè (1986) is used as a basis for this aspect of model development. Demand functions for the poultry industries have also been endogenized and transportation activities for poultry products added.

The policy change examined deals with a move towards complete trade liberalization. In order to examine changes expected in Canadian agriculture, estimates of world prices under a trade liberalization scenario as provided by the SWOPSIM model are used (Roningen and Dixit, 1988). The SWOPSIM model has expanded upon the methodology used by the Organization for Economic Co-operation and Development (OECD, 1987). Roningen and Dixit have used this 11-region, 22-commodity model to examine a 1986/87 world trading picture where producers, consumers and traders operate under an environment which calls for the elimination of all subsidies to agriculture in the industrialized market economies. Their results show that world production levels would fall and prices would, on average, increase by 19 percent. The rise in world prices would be greatest for dairy products (50%) and sugar (39%), wheat prices would increase by 30%, coarse grains by 23% and ruminant meats by 18%. In the case of oilseeds where past agricultural policies of industrial countries have interfered only moderately, a 7% increase in prices is expected. The change expected in eggs and poultry meats is 12%. These prices are taken as exogenous and the CRAM model is then used to estimate supplies to the market under this revised domestic and world price regime. Estimates of changes in sector earnings on a provincial basis are provided.

Information on the marginal costs of production for dairy and poultry producers is crucial to assessing possible impacts of the liberalized world agriculture trade. Therefore, conceptual issues relating to the specification and estimation of supply curves for industries subject to supply management schemes are examined. The capital asset pricing model theory is reviewed and the relationship between it, quota values and the position of producers on their supply curve is outlined.

1.4 Scope of the Report

This report provides estimates of changes in regional production patterns, supply responses, trade flows, and provincial and national sector earnings levels that may be expected for each of the major commodity groups as Canada, and other countries, move together to a free trade environment under the principles of GATT. In Section 2 of this report several different components of CRAM's structure and specific changes thereto, as made in this study, are noted. Section 3 of the report deals with the problem of attempting to link the CRAM model with world price changes as provided by the SWOPSIM model in their scenario where industrialized countries eliminate subsidies and move to free trade. Section 4 details the results of this study and Section 5 provides a summary and discusses policy implications that arise from the study.

SECTION 2

SUPPLY PRICES AND THE STRUCTURE OF CRAM

In this section several different components of this study are noted, particularly as they relate to the CRAM model and the world trade setting. First, the problem of estimating supply responses for these sectors and the problem of positioning producers on their supply curves in each of the provinces is addressed, since the emphasis in this study is on changes that are expected in the supply controlled industries. Second, structural specifications of the CRAM model are reviewed. Third, since any changes in milk production at the farm level must be marketed either as fresh milk or as manufactured milk products, the respecified processing segment of the CRAM dairy block is detailed for this study. Fourth, the retention function concept used in CRAM is reviewed. This procedure allows opening and closing herd sizes to be adjusted for changes in expected levels of future profits.

2.1 Supply Responses and Quota Values

To assess the impacts of trade liberalization scenarios on the dairy and poultry sectors of Canada it is essential to determine the supply functions for these sectors. Furthermore, assuming that the shape and slope of these can be established, one wants to be able to position producers on this function under present circumstances where supplies to the market are restricted. This section attempts to summarize some of the concepts and findings on this issue (See Barichello (1981 and 1984); Veeman (1982); Schmitz (1983); Moschini (1988); Moschini and Meilke (1988) and others).

In the Appendix of this report, it is shown that farm supply responses are relatively easily estimated in the case of agricultural commodities where one can observe output responses to input and output prices and no supply controls exist. A basic result of the duality approach of microeconomic theory is that under cost minimization behaviour the cost function represents an alternative description of the production technology that underlies production relationships between inputs and outputs. From this setting the supply response of the firm can be derived assuming profit maximizing behaviour. Given a profit function (π) which is a function of product prices (p) and input costs (w), the supply function is obtained by Hotelling's lemma: $y(p,w) = \delta\pi/\delta p$. Comparative static analysis of the first order conditions of the profit function show that the slope of the supply function is the reciprocal of the slope of the marginal cost schedule. Hence, given a random sample of observations on output levels, input costs and output prices it is possible to estimate this function. Standard specification issues include, among others, the choice of a functional form and an explicit formulation about how expectations are to be handled.

In industries where production quotas exist one can also estimate a supply function, based the same information and assumptions as above, provided a rental market for quotas exist. In this instance, the profit function is modified to account for rents of this quota and the first order condition for this profit function shows that the quota rental price will be equal to the difference between the product price and the marginal cost of production.

The main problem with this approach is that it may or may not be possible to observe quota values and/or the rental prices of these (Barichello and Cunningham-Dunlop, 1987), depending on the regulations under which boards of the different commodities in the different provinces operate. In fact, the rental market for quotas is either extremely thin or prohibited. Therefore, alternative methods must be considered.

Traditionally, there have been two strategies for empirically estimating supply functions. The first strategy would be to compute the shadow or supply price for the commodity as the difference between the administered price in the market and the quota rental price, provided one can obtain estimates of the rental prices of quotas. This computed shadow or supply price could be used to estimate the inverse supply response functions. However, since by definition quotas control supply, one is likely to find very little variation in output levels in a time series sample and therefore little information is available for the estimation of relevant parameters. One must also obtain reasonable estimates of quota rental prices from observed farm level quota values or from farm-level cost function estimates for the approach to be successful.

In the second strategy, one may estimate an aggregate restricted profit function directly in a multicommodity approach. Here observations on the output levels and input prices of industries under supply management are required, as are the output levels and output prices for commodities not controlled by supply management schemes. This approach does not require information on quota rental rates but increases the econometric problems. For example, one needs to estimate a large number of parameters relative to the size of time series data usually available.

Given the difficulties associated with these two approaches, this study has adopted a hybrid of the first strategy. Since information on the capital value of quota is usually more easily obtainable than rental values, this is used to determine supply prices. Quotas can be viewed as assets where their value is equal to the discounted value of present and future returns; the returns being equal to the difference between prices and marginal costs of production. Hence, if asset values of quota are known it is possible to estimate this difference between the administered price and the marginal costs by using an appropriate discount rate. The main problem is to decide on an appropriate discount rate; one that needs to allow for expected gains or loss associated with holding quotas, expected real interest rates, the appropriate planning horizon, the risk associated with holding the asset, and other considerations. The problem has been analyzed extensively by Barichello (1984), Lermer and Stanbury (1985), Moschini and Meilke (1988) and others.

In Figure 2.1 the administratively controlled supply level is shown as Q_s, the supply price of producers is shown as P_s and the market price as P_m. Quota values in aggregate may be interpreted as a measure of the capitalized value of the economic rent created by restricting supply. These economic rents are represented by area P_mACP_s in Figure 2.1, while the per unit quota value is $(P_m - P_s)$. The area P_mABP_e - BCD represents the increase in producers surplus resulting from the imposition of supply management.

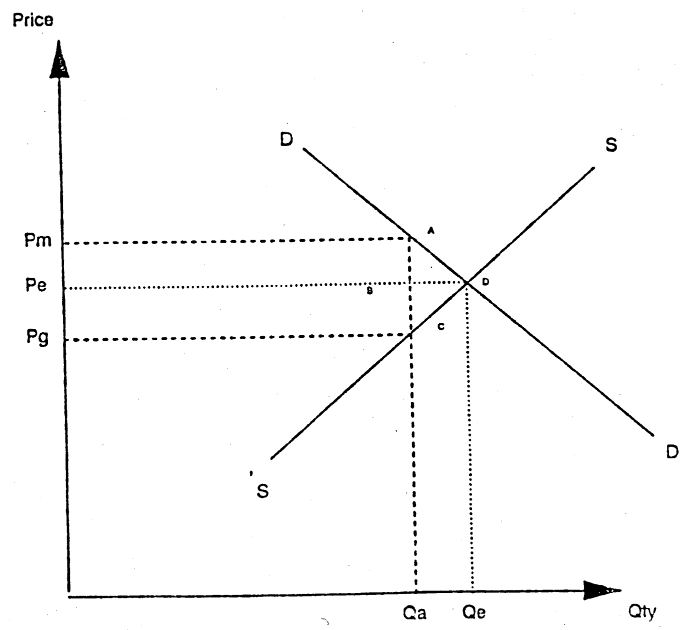

Fig. 2.1 Producer Surplus Areas and Rents under Supply Management

Forbes, Hughes and Warley (1982) have also shown that the analysis is not quite as simple as the case presented. One needs to consider whether production costs are actually shifted by the rules under which boards and transfer schemes operate and whether a change in a farmer's perception of risk will shift the supply curve. One also gets into questions relating to the under-utilization of fixed facilities on certain farms where the marginal cost of incremental output may be quite low and the amount these producers are prepared to pay for extra quota will be different to a new entrant. It has been argued that if rents exists these are built into the prices of resources and if this aspect is not considered the producer surplus area shown in Figure 2.1 overstates the value of quota rights.

Given the many difficulties associated with attempting an econometric estimation of supply functions, the approach taken in this study to estimate the supply price of producers in the dairy and poultry sectors is to value a unit of quota as being equivalent to the net present value of the stream of net returns accruing to that asset. Hence:

$$\text{Capitalized Value of Quota} = \sum_{t=1}^{n} \frac{(\text{Average Revenue} - \text{Supply Price})}{(1 + r)^t}$$

By knowing the value of quota in the market, it is possible to calculate the supply price from the above formulae.[1]

The work presented in this section is based on quota values used and reported by Bollman (1988). Both published data and a survey involving formal and informal information sources was used to collect these values. No attempt has been made in this study to adjust or correct these quota values for differences that exist between provinces in transfer regulations on quota rights.

These calculations for the dairy sector are presented in Table 2.1. As noted the average price received by milk producers varies by province and is dependent upon the relative shares of milk going to the industrial or fluid markets. For 1986, this price was $49.55 in B.C., $40.25 in Quebec and $43.95 in Ontario. To arrive at an appropriate discount rate it was decided that a weighted rate based on the share of sales to each market would be used — in the industrial market a discount rate of 11.6% is used and 19.4% for the fluid. This results in discount rates that vary between provinces, 16.6%, B.C. to 13.5% for Quebec. The supply prices are calculated for each province based on the capitalization formulae noted above . In Quebec, this is estimated to be $31.58 per hl, and hence, the market price is 27% above the supply price or marginal cost of production (Table 2.1).

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1 For a more detailed explanation of the procedures used in estimating these supply prices see the Appendix.

Table 2.1: Estimated Supply Prices for Milk Production in Canada, by Province, 1986[a/]

Province	Average Milk Price[b/] ($/hl)	Quota Values[c/] ($/hl)	Discount Rate[d/] (%)	Supply Price[e/] ($/hl)	Sup-ply Price[f/] ($/c-ow)
PEI	36.68	27.00	12.8	33.22	1561
NS	46.78	80.00	16.8	33.34	1834
NB	43.95	50.50	15.9	35.92	1868
QUE	40.25	64.20	13.5	31.58	1548
ONT	43.95	76.20	14.9	32.60	1662
MAN	42.47	65.70	15.0	32.62	1533
SASK	44.81	56.50	15.1	36.17	1772
ALTA	41.90	47.30	15.1	34.76	1807
BC	49.55	116.70	16.6	30.18	2053
NFLD	64.62	NA	19.6	NA	NA
CANADA	42.69	69.7	14.5	32.58	1662

a/ Source: See the Appendix
b/ Blend price of industrial and fluid milk.
c/ Estimates provided by Bollman.
d/ Weighted average of assumed fluid milk discount rate of .194 and industrial milk discount rate of .116.
e/ Calculated as shadow price - Average Price - (estimated discount rate x capitalized quota value).
f/ Based on Bollman's estimates of milk production per cow.

These calculations show that B. C. is the lowest cost producer, followed by Quebec and Ontario. In B.C. market returns are 39% above supply prices, while in Ontario they are 26% above. In the prairie provinces, the gap between market returns and supply prices averages about $8.5 per hl, supply prices average $34.5 and hence a difference of 25 percent.

These estimates provide an important reference point for the results of this study. In the absence of controls, dairy producers will move along their supply function to an equilibrium where marginal revenue and marginal costs are equal. Hence, in this study, it is assumed that under the free trade scenario, producers in each of the provinces will expand if market returns are above supply prices and vice versa. Given the SWOPSIM model results, world dairy product prices are expected to increase. Canadian supply prices for most provinces are below this level and under complete liberalization there will be an expansion in the size of our dairy sector.

Several factors determine the size of this expansion in the dairy sector: the exact increase in product prices expected, the difference between farm gate returns for each province and supply prices as estimated for this study, the assumed elasticity of supply (+1.0 for this study), and, the change in feed costs for dairy producers under this scenario (a feed price elasticity of -0.3 is assumed).[2] Changes expected under these assumptions and conditions are noted in the results section of this report.

A similar capitalization procedure has been followed in deriving supply prices for the broiler, layer and turkey industries. The results are presented in Table 2.2, and are based on estimated quota values and an assumed discount rate of 15% . In the case of broilers, B.C. and Ontario are shown to be the low cost producers. The average Canadian supply price is $0.87/kg. It is estimated that the supply price is approximately 33% less than farm gate returns under controls, assuming the average Canadian farm gate price of $1.10/kg . This gap is about 16% for Alberta and Manitoba and about 23% for Quebec.

Results for the layer and turkey sectors are also noted in Table 2.2. Once again B.C. and Ontario are the low cost producers with gaps of 80% and 68% being noted. As with dairy, one is interested in attempting to examine changes in these sectors when supply controls are removed and producers face market prices set at a world level.

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2 Refer to the Appendix for more details on elasticities.

Table 2.2: Estimated Shadow Supply Prices for Broilers, Eggs and Turkeys in Canada, by Province, 1986[a/]

	BROILERS				EGGS				TURKEYS			
	Quota Values[c/] ($/bird)	Av. Monthly Price Live Poultry[b/] ($/kg)	Supply Price ($/kg)	% Diff.[d/]	Quota Values[c/] ($/bird)	Price[e/] ($/doz)	Supply Price ($/doz)	% Diff.[d/]	Quota Values[c/] ($/bird)	Av. Producer Price ($/kg)	Supply Prices ($/kg)	% Diff.[d/]
PEI	NA	NA	NA	NA	5	0.98	0.92	7	NA	NA		
NS	1.49	1.15	1.03	13	15	0.97	0.80	21	2.52	1.53	1.40	9
NB	1.23	NA	NA		10	0.95	0.84	13	2.50	NA		
QUE	2.86	1.07	0.87	23	30	0.93	0.61	52	6.54	1.40	1.15	18
ONT	3.58	1.09	0.82	33	35	0.91	0.54	68	11.99	1.42	1.05	35
MAN	1.64	1.07	0.93	15	25	0.85	0.58	46	6.68	1.44	1.20	20
SASK	1.04	NA	NA	NA	15	0.90	0.72	25	1.69	1.52	1.27	20
ALTA	2.06	1.11	0.94	18	20	0.91	0.68	34	6.23	1.53	1.28	20
B.C.	4.22	1.12	0.81	34	40	0.94	0.52	80	7.30	1.52	1.27	20
NFLD	1.16	NA	NA		10	1.02	0.92	12	NA	NA		
CANADA	2.97	1.09	0.87	25	29.6	0.92	0.60	53	8.64	1.44	1.19	21

a/ Source: See the Appendix
b/ Poultry Market Review, 1986, p. 10, Av. Price for broiler chickens (under 2.3 kg. live)
c/ Estimates by Bollman (1988)
d/ (Producer Price - Supply Price)/(Supply Price) *100
e/ Poultry Market Review, 1986

These estimates of supply prices should be treated with caution. They are provisional and are used in an interim sense until more reliable estimates become available. A more detailed survey of quota values is required and the capitalization formulae approach adopted has not adequately catered to some of the problems noted earlier.

2.2 The Basic Structure of CRAM

The results of changes in the supply managed industries which result from the free trade scenario to be examined within the CRAM model. The analysis provided by CRAM is of a comparative static and partial equilibrium nature. To help understand and interpret these results a very brief overview of CRAM is provided.

The Canadian Regional Agricultural Model (CRAM) is a multi-commodity, multiregion linear programmmming model. The following summary provides some additional features of the model:

Model Characteristics:

- Static, spatial, partial equilibrium linear programming model focused upon the major agricultural sectors.
- Contains 5 major geographical levels - national; eastern and western Canada; provincial (combining the maritime provinces); crop region; and export or shipping points.
- Contains 29 crop regions - 22 in the Prairies and one for each of the remaining provinces.
- Grains, oilseeds, dairy, beef, pork, eggs,and poultry are included. Fruit and vegetables are not included.

- Fairly detailed production input relationships are included in the model, allowing examination of both the direct and indirect effects of changes in government policy.

- Unit costs, opening grain stocks, livestock inventories, and certain import and export levels are exogenously specified.

- Models supply and demand relationships for all major commodities.

- Uses assumed elasticities of supply and demand, based on literature searches, which represent the expected responsiveness of supply/demand to price changes.

- Shipments of livestock, livestock products and grains occur to meet provincial demand levels, with excess demand/supply met by import/export activities.

- Trade activities respond to export and import prices, specified in the model as domestic floor and ceiling prices.

- The model assumes Canadian trade will not affect world or North American prices.

The Crop Block:

- Crops modelled include wheat (4 grades), barley (including other coarse grains), flax, canola, corn, soybeans, hay, pasture and other crops.
- The model permits choice among the various crops, given the constraints of soil and climate on yield.

- Choice also occurs between grain crops, hay, pasture and fallow (using a set of fallow ratios).

- Crop rotations are very important, since yields will vary when planted on fallow vs. stubble.

- Crops are grown in 29 geographic regions, differentiated primarily by soil and climatic zones.

- Crops produced in these regions are transferred to the provincial level to meet the demand for livestock feed and domestic consumption, or transferred to port for export.

The Livestock Block:

- Beef, pork and dairy production activities are modelled in detail, while the poultry sector is modelled as single activities for each of broiler, egg and turkey production.

- Diets are expressed in terms of stored forage, pasture and barley for beef and dairy animals; barley for hogs; and wheat for poultry. Grain input substitution is possible. Protein supplement feeding is not accounted for at this time.

- Opening stocks, input requirements (including diet and cash costs), and replacement ratios are all specified to determine yield, closing stocks and price.

- Livestock inventories, prices and government payments are set at 1986 levels, and the demand functions are calibrated to replicate prices and consumption in that year.

- Livestock inentory retention functions specified are based on econometrically estimated relationships.

<u>Government Programs</u>:

- Expected payouts under each of the various programs are used to supplement market returns.

- Programs explicitly modelled are:
  Western Grain Stabilization Act
  Agricultural Stabilization Act
    - Crop Insurance
    - Federal and Provincial Red Meat Stabilization Programs
    - Two Price Wheat Program
    - Input Subsidies
    - Special Canadian Grains Program
    - Western Grains Transportation Act
    - Feed Freight Assistance
    - Dairy Levies and Subsidies

- The benefits of supply management for the dairy and poultry sectors are captured.

- The model assumes farmers view government payments as equivalent to market receipts.

2.3 The Dairy Processing Subsector in CRAM

Changes in milk production at the farm level need to be considered in terms of their impacts upon processing and marketing of manufactured dairy products. Milk itself is not traded between countries; however, the world prices of manufactured products, namely butter, cheese and skim milk powder are set in an international market. Plant operators have the option of diverting fresh milk supplies into several different fresh or manufactured products, and the changes in the mix of products is important measure of how the industry adjusts to trade liberalization. It is therefore considered important that the options open to manufacturers be modeled in CRAM, thereby providing a link between farm gate supplies, the manufacturing sector and demands for the different products was respecified for this study.

The approach follows that used by Short and Côtè (1986). However, rather than specifying a single 'Canadian level' manufacturing sector, the processing and marketing activities are defined on a province by province basis. Provincial level fresh milk supplies are thus linked to provincial level demand functions and shipment between provinces of manufactured items takes place in order to balance supplies and demands in each of the provinces and take advantage of any arbitrage opportunities. Short and Côtè assumed supplies to the market at a national level were fixed for fresh milk, industrial milk and cream shipment levels. Their model, and the CRAM model modified for this study, balances milk supplies, fat (BF) and solid-not-fat (SNF) supplies with demands for milk sold and that used to manufacture different products.

In CRAM, seven types of dairy products are specified: fresh milk, low fat milk, creams, cheese, butter, skim milk powder and other dairy products. A "sink" for other final products is used to balance butterfat and solid-not-fat supplies in the model ensuring completeness and consistency. On the demand side, stepped demand functions are used for some products and point demand for others.

The key to the model on the manufacturing side is a set of balance equations for BF and SNF. These balance equations constrain production in that the total BF and SNF used in the manufacture of the different dairy products is less than or equal to supplies delivered by farmers in the form of fluid milk, industrial milk and farm separated cream.

The dairy model as now specified in CRAM for this study differs from this earlier model in that a manufacturing sector for all provinces is detailed and, in addition, farm gate supplies are allowed to vary depending on the policy framework. Furthermore, in the base case, production is fixed wheras for this trade liberalization study, the assumption of fixed supplies and quota controls is changed. The following set of equations, defined by province, detail the main components of the dairy processing sector of the CRAM model:

(1) **Milk Balance**

Fluid Market Milk Production + Industrial Market Milk + Production Overquota Milk + Production Industrial Cream - Production Total Provincial Supply Raw Milk ≤ 0

(2) **Fluid: Industrial Ratio**

Fluid Market Milk Production - (Industrial Milk (including overquota) Production)* (Proportion of Total Which Goes to Industrial) ≤ 0

(3) **Industrial Cream Ratio**

Total Raw Milk Production - (Industrial Cream Production)* (Proportion of Production Which Goes to Cream) ≤ 0

(4) **Market Share Quota**

(Industrial Market Milk Production)* (Amount of Butterfat Per Hectolitre) + (Industrial Cream Production)* (Amount Butterfat Per Hectolitre) ≤ Provincial MSQ Level in Tonnes Butterfat

(5) **Milk Component Balances**

(a) **Fluid Butterfat**

- (Fluid Market Milk Production)* (Amount Butterfat Per Hectolitre) + Transfer (tonnes) of Butterfat to Industrial Market + (Production of Fluid Market Final Products) *(Amount of Butterfat Per Unit) ≤ 0

(b) **Fluid Solid Non Fat**

- (Fluid Market Milk Production)* (Amount of SNF Per Unit (Hl)) + (Production of Fluid Market Final Productions)* (Amount SNF Per Unit (Hl)) ≤ 0

(c) **Industrial Butterfat**

- Industrial Market Milk Production Times Amount Butterfat Per Unit (Hl) - Over Quota Milk Production Times Amount Butterfat Per Unit (Hl) - Industrial Cream Production Times Amount Butterfat Per Unit (Hl) + Production of Industrial Market Final Products Times Amount Butterfat Per Unit (Hl) ≤ 0

(d) **Industrial Solid Non Fat**

- Industrial Market Milk Production Times Amount SNF Per Unit (Hl) - Over Quota Milk Production Times Amount SNF Per Unit (Hl) - Industrial Milk Production Times Amount SNF Per Unit (Hl) + Production of Industrial Market Final Products Times Amount SNF Per Unit (Hl) ≤ 0

Equations #1, 2 and 3 allocates raw milk from the farm sector to one of four uses: the fluid milk market, industrial milk market, overquota milk and industrial cream. A ratio of fluid to industrial per province ensures the fluid quota levels are not surpassed. The rest of the milk after fluid is removed goes to one of the three industrial supplies.

Equation #4 controls the industrial cream supply through the use of a ratio related to total milk production. This along with the remaining milk in a province draws upon market share quota (MSQ). Once the MSQ is used up for a province any excess production must go into overquota milk. A milk balance row ensures the use for these four activities does not exceed the raw milk supply.

Equation #5 breaks the different supplies of milk into their BF and SNF components in the four milk component balance rows. Fluid milk components enter the industrial balances. On the other side, the final products draw from their respective markets balance rows. This ensures the amounts of butterfat and SNF used by the fluid or industrial production does not exceed the amounts available from the supplies of milk.

Associated with the manufacture of milk products are processing costs and other levies or subsidies, with must be defined within the model. The following accounting equations are defined, by province, for this sector:

(6) Cash Costs

- Levy's	+ Subsidies	- Total Dairy Processing Sector Cash Costs	≤ 0

(7) Processing Costs

(Activity for Processing Dairy Product)* (Unit Processing Cost)	- Total Processing Costs	≤ 0

(8) Levy's

(Fluid Market Milk Production)* (Skim-Off Levy)	+ Industrial Market Milk Production Times In-quota Levy	+ Overquota Milk Production Times Over-quota Levy	- Levy Total	≤ 0

(9) Subsidy

- (Industrial Market Milk Production)* (Subsidy)	- (Industrial Cream Production)* (Subsidy)	+ Subsidy Total	≤ 0

The butterfat subsidy along with the skim-off, in-quota and over-quota levy's are associated with the activities for the four basic milk supplies. The fluid market milk has a skim-off levy to cover the movements of butterfat to the industrial sector. The industrial milk (within MSQ) is charged an in-quota levy, but receives the butterfat subsidy. Over-quota milk production is charged the large over-quota levy. Finally, industrial cream receives the butterfat subsidy but is not charged any sort of levy. Further documentation of this component of the model is provided in the technical report component of this study that deals with the structure of the CRAM model.

Once the products have been manufactured they move through to the demand sector. This is done through the use of the transfer rows that link the manufacturing sector to transport and demand activities in CRAM.

Given this linkage between demand and the processing sector of the model, it is possible to specify changes within the dairy sector that may be expected as Canadian supplies and demand levels fall in line with new set of world prices under trade liberalization. It is assummed that quota and all border controls are removed. In the base case, the balances between supplies and uses of BF and SNF are derived given predetermined interprovincial or international import and export levels for the different products at a provincial level. The model is then used in a simulation sense to examine alternatives facing the sector.

2.4 Investment and Disinvestment Rules

This section outlines the methodology adopted in CRAM to allow for the investment and disinvestment decisions of livestock and poultry producers. The approach was first adopted in a study of the beef and hog sectors (Webber, Graham and MacGregor, 1988). The model and supporting software programs were modified in this study to allow for the same decision rules to be incorporated into the dairy and poultry components of CRAM.

The basis of the procedure is to allow for opening and closing dairy herd or poultry flock sizes to be adjusted to changes in expected levels of future profits. A survey of the literature shows that it is extremely difficult to correctly incorporate assets investment and disinvestment rules into the decision framework adopted in CRAM. This alternative approach uses exogenous estimates of own price, cross price, or input cost elasticities, together with information on the change in the level of these variables, to allow herd and flock sizes to adjust. Since the results reported in this study depend upon the approach used to specify investment and disinvestment decisions, this section summarizes the methodology.

Attempts to understand fluctuations in investment levels of livestock producers at an aggregate level are based upon an understanding of the decisions made with respect to assets at the firm level. In the beef sector, Rosen (1987), Trapp (1986), Jarvis (1974) and others have focused their studies on herd inventory decisions and changes that result in supplies to the market in the short-run and long-run as the investment levels in these assets vary. The basic decision by a producer of whether to hold or cull an animal is based upon a comparison of selling now at a known output price or keeping the cow and her future calves until some future date when both are sold at uncertain prices. Animals are culled if the expected present value of all future net revenues from that animal is less than the current value of the animal and vice-versa for additions. The same rules apply to dairy cows and sows.

The above rules appear deceptively simple but, as pointed out by Trapp (1986), they are extremely difficult to operationalize. A large amount of information is required such as future prices, growth rates, and death losses.

In the absence of this type of information and because of the difficulties involved in attempting to model these investment and disinvestment rules in CRAM, econometrically estimated behavioural response relationships are used. This econometrically defined past

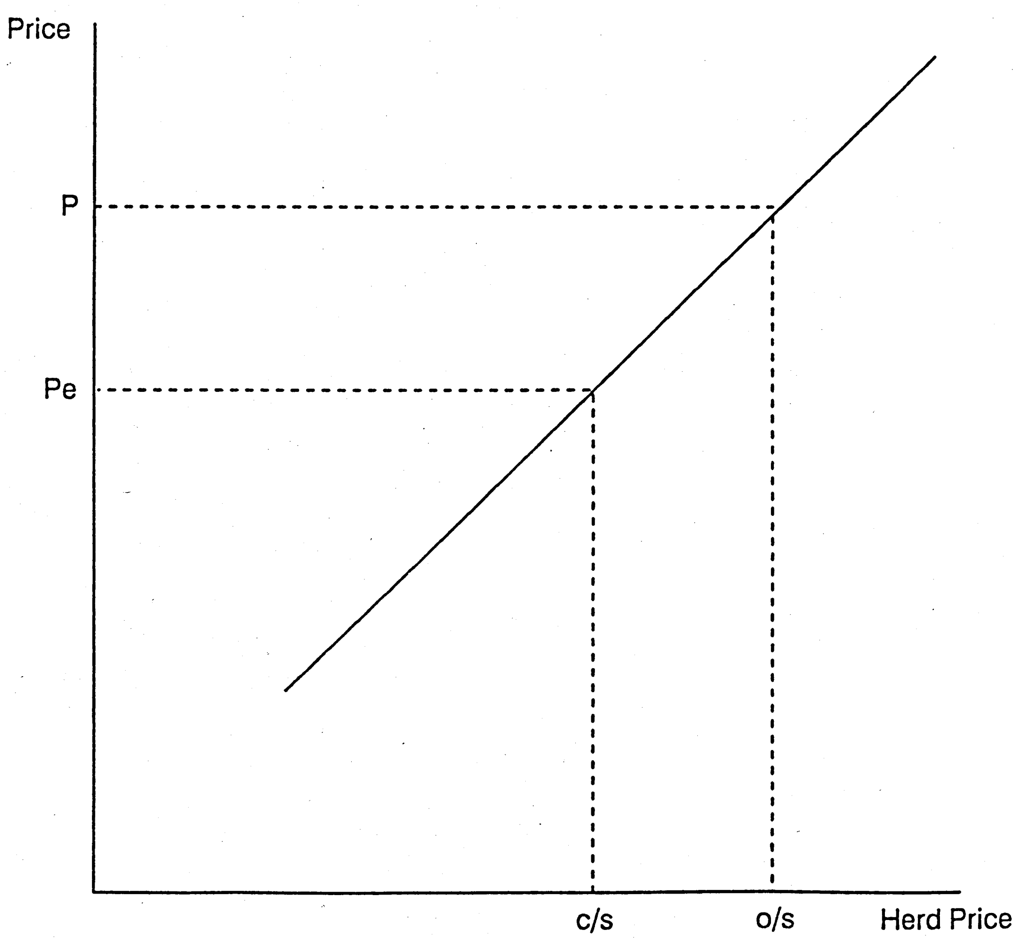

FIGURE 2.2: SIMPLE PRICE/INVENTORY RELATIONSHIP

behaviour is used to forecast herd build-ups or reductions. The essential relationship that needs to be captured is that between opening stocks of animals, closing stocks and price changes. A simple inventory/price relationship is illustrated in Figure 2.2. Opening cow (o/s) numbers and an existing price (p) are given. Assuming a positive slope for the retention function, closing numbers (c/s) are expected to be some function of future profits or price (P_e). When expected prices or profits are lower than current prices then the herd size will decrease (from o/s to c/s). The slope of this relationship will change depending on the livestock category involved (and animal class within each livestock category) and it may shift depending on other factors, e.g. feed costs. The slope could possibly also be negative over some time periods for some animal classes indicating that as prices increase inventories are decreased.

The analysis can consider both short-term and longer-term adjustments. The elasticities for adjustment vary depending on the time-period, and are determined exogeneously. In the case of short-term adjustments, a one-year period is considered appropriate. Longer-term adjustments may be captured by solving the model recursively over a number of years with short-term adjustment parameters. Alternatively, in a comparative static sense, long term elasticities may be specified.

The general form of the stock retention function for use in CRAM is specified as:

$$S = S(X_1, X_2, ..., X_n) \quad (1)$$

The total differential of this function is

$$dS = \frac{\delta S}{\delta X_1} . dX_1 + ... + \frac{\delta S}{\delta Xn} . dX_n \quad (2)$$

where each term on the right side indicates the amount of change in the retained stock, S, resulting from an infinitesimal change in one of the independent variables.

If the stock retention function has the following linear form:

$$S = a_0 + a_1 X_1 + a_2 X_2 + ... + a_n X_n \quad (3)$$

then the partial derivatives can be written as:

$$\frac{\delta S}{\delta_{xi}} = a_i \qquad (i=1,..........n) \quad (4)$$

and equation 2 becomes

$$dS = a_1 * dX_1 + a_2 * dX_2 + ... + a_n * dX_n \quad (5)$$

In discrete time, equation 5 can be written as the following difference form:

$$S_1 - S_0 = a_1 * (X_{1,1} - X_{1,0}) + ... a_n * (X_{n,1} - X_{n,0}) \quad (6)$$

where

S_0 = stock at time 0 (opening stock)

S_1 = stock at time 1 (closing stock)

$X_{i,0}$ = level (or price) of variable i at time 0

$X_{i,1}$ = level (or price) of variable i at time 1

In general, the elasticity of stock retention with respect to variable X_i is defined as:

$$\epsilon_{s,Xi} = \frac{\delta S}{\delta X_i} \cdot \frac{X_i}{S} \quad (7)$$

Therefore, each partial derivative can be derived from the corresponding elasticity as follows:

$$a_i = \frac{\delta S}{\delta X_i} = \epsilon_{s,Xi} \cdot \frac{S_i}{X_i} \quad (8)$$

Consequently, given the open stock (S_0), the levels of each independent variable (X_i) at time 0 and 1, and the set of elasticities, the closing stock (S_1) can be computed.

The elasticity in equation 7 is defined in terms of the slope of the stock retention curve at a particular point on the curve. A policy change could effect S, the level of X_i, or S/ X_i, and thus, the elasticity could be altered. In terms of the policy analyses, the model could be solved for various elasticities and the results compared in a comparative static sense. To operationalize this concept elasticities of retention with respect to important variables and expected variable changes must be provided.

Dairy cow numbers or flock herd sizes are extremely important in that it is the opening and closing livestock numbers that determine flows to the market and earnings to the sector. Product price changes, input cost changes and changes in several other important variables will determine investment or disinvestment levels. In Table 2.3 own supply price and feed price elasticities

TABLE 2.3: OWN SUPPLY PRICE ELASTICITIES AND FEED PRICE ELASTICITIES[a/]

	Supply Elasticity	Feed Price Elasticity
Dairy	1.0	-0.3
Broilers	0.8	-0.6
Eggs	0.9	-0.6
Turkeys	1.7	-0.6

[a/] Source: See the Appendix

used in this study for the dairy and poultry sectors are reported. A review of the literature for these elaticities was undertaken and these represent a consensus of long-run estimates. However, these parameters may be parametrically varied in order to examine the sensitivity of the results reported.

In summary, there are many difficulties involved in attempting to endogenize closing livestock numbers, so an alternative approach has been followed. The procedure allows opening and closing numbers of herd and flock sizes for different animal and poultry categories in each province to be determined based upon retention function elasticities that have been previously estimated. Where this information is not known the user may specify their own adjustment responses based upon expert opinion. The matrix generator for this study has been modified accordingly, thus allowing for opening and closing stock numbers (investment levels) in the beef, hog, and dairy sectors of the study to vary based upon future expected profit levels. The same procedure is followed in the poultry sector except that flock sizes (both opening and closing) are set at a given level based upon the expected future profit levels. The shorter production cycle of layers, broilers and turkeys allows more immediate changes in investment levels and hence supplies to the market.

SECTION 3

WORLD & CANADIAN PRICES

This section deals with how SWOPSIM's (Static World Policy Simulation Model) world prices are linked to Canadian prices for all major commodities specified in CRAM model. It is expected that if the Industrial Market Economies (IME) agree, multilaterally, to eliminate all subsidies, there would be an increase in world prices. The purpose of this analysis is to examine how these increases in world prices effect Canadian production level.

In order for Canadian farmers to benefit from higher producer prices, it is assumed that both provincial and federal governments change their policies as they relate to the subsidies paid to producers. An extreme position is examined in this paper -- that of an elimination of all producer or consumer subsidies to producers in all IME countries, including Canada. This corresponds to the scenario adopted by Roningen and Dixit (1988). There are, of course, other less radical positions that may be examined but the chosen scenario is useful in that it represents an extreme change.

3.1 SWOPSIM Results

The SWOPSIM work of Roningen and Dixit has adopted and expanded upon the methodology used by the OECD (1987). It provides updated and more comprehensive answers to the question of how trade liberalization would affect trade and economic welfare of various countries. It draws upon a 22 commodity, 36 country/region data base with 1986 being the last year of complete data. The model may be aggregated to different levels depending on the policies being evaluated. It is non-spatial in the sense that directions of net trade flows are not specified, and therefore is synthetic and linear. It is also a medium-run static model. Within given domestic supply and demand elasticities and a summary of government policy measures (direct payments and price wedges derived from measures of Producer (PSE) and Consumer Subsidy (CSE) Equivalent measures), it is possible to remove or change policies in a bilateral or multilateral sense. The impact of these changes on domestic supplies, demands, trade and prices can be measured and analyzed.

SWOPSIM was recently employed to investigate the implications of significant trade liberalization of industrial market economies. In this analysis, all government programs, either as direct payments or price wedges, captured by the PSE in the base year 1986 were removed and the SWOPSIM model solved for a new equilibrium. The results from the SWOPSIM model are summarized in IATRIC (1988).

Of fundamental importance for federal and provincial policy-makers and for producers in each of the different producing regions is anticipating the changes that occur as one dismantles price and support schemes in Canada and elsewhere. If PSE's (or a modified version of them) are gradually reduced, what types of changes may be expected within each of the provinces of Canada? This is not straight forward because Canadian policies do not apply equally across the country. Some policies have tended to fix production patterns and resource use, and significant cross commodity affects are also anticipated if changes are made following the SWOPSIM scenario. The analysis is further complicated by the fact that some markets have been largely disconnected from world markets — the poultry and dairy markets — while in most other markets the price transmission elasticities have remained relatively high.

A new equilibrium for world trade and prices is obtained when all PSE's and CSE's are removed on a multilateral basis. These new equilibrium levels represent a medium to longer run situation because it is assumed that adjustments take place over a 5 year period. All other conditions, particularly those relating to supply elasticities and the position of these, are held constant at the base year (1986/87) levels. Differences between this new solution and that of the base year are attributed to the removal of all producers and consumer subsidies.

World price changes and subsequent Canadian farm level price changes for the free trade scenario are reported in Table 3.1. World trade prices reported in SWOPSIM are 1986 U.S. dollar values. The SWOPSIM results show that world prices for wheat, coarse grains and corn will increase 29%, 20% and 24% respectively. The increase in the world price for soybeans and canola are less due the lower level of support provide these commodite, in aggregate, than for other crop commodities. Beef prices increase 18%, pork by 11%, poultry meats by 18% and eggs by 5%.

In order to assess the impact of these changes at the Canadian level it is necessary to calculate the net change in Canadian producer returns as a result of these changes in world prices. First, producers may expect market return increases, by commodity, similar to those reported above. However, since all subsidies from governments are eliminated, producers receive nothing from this source. The net change in producer receipts needs to be calculated, and then specified in the objective function of CRAM.

To understand the implications of the free trade scenario, take the case of wheat in Table 3.1. The farm gate price for wheat from the market for 1986/87 is $117 tonne. In addition, producers received approximately $47/tonne in the form of direct subsidy payments and $35/tonne in other assistance forms classified as "wedge other than direct payments" in the SWOPSIM model (transport subsidies, two-price wheat policy, Canadian Wheat Board pool deficits, corn competitive price policy and others). The total PSE

Table 3.1: World and Canadian Price Changes Under Free Trade based on SWOPSIM model Results (m.t. in 1986 - ($1 US = 1.3895 CDN))

	WORLD			CANADIAN					
Product	Base Price ($US/unit) (a)	Free Trade Price ($US/unit) (b)	% Change	Farm Gate Price ($/unit) (c)	Direct Payments ($/unit) (d)	Total Farm Gate Returns (c+d)	Free Trade Farm Gate Prices[1] (% change)[2] (e)	Wedge Other than Direct Payments (f)	Total PSE Wedge (d+f)
Wheat	160	207	29	117	47	164	130 (-21%)	35	82
Barley (coarse grain)	114	137	20	65	27	92	66 (-28%)	23	50
Corn	121	150	24	87	25	112	108 (-4%)	8	33
Soybeans	289	297	3	234	51	285	219 (-23%)	23	74
Canola	450	511	14	199	90	289	202 (-30%)	48	138
Flax	-	-	-	171	64	235	164 (-30%)	46	110
Beef	2905	3428	18	2800	74	2874	3087 (7%)	234	308
Pork	3235	3611	11	1793	28	1821	1967 (8%)	192	220
Poultry	1505	1744	18	1507	0	1507	1720 (14%)	56	56
Eggs	2980	3125	5	3471	0	3471	3125 (-10%)	491	491

Source: SWOPSIM results (Roningen and Dixit - International Ag. Trade Research Consortium Symposium, 1988)

1 Free trade farm gate prices for Canadian producers derived from SWOPSIM.

2 % Change is between total farm gate returns in base and free trade farm gate prices.

wedge for direct subsidy payments and other indirect payments amounts to $82/tonne. If direct subsidy payments alone are considered total farm gate returns to producers amount to $164.

The SWOPSIM model reports that Canadian wheat producers under a trade liberalization scenario will receive market returns of $130 per tonne. Hence, market returns increase from $117 to $130, a 11% increase. With this scenario it is also assumed that indirect support payments grouped as "wedge other than direct payments" are removed and hence the margin between world prices and farm gate prices increases. Hence, although world prices increase by 29%, Canadian farm gate prices increase by only 11% because producers now face a situation in which all "wedge" or indirect payments are removed. Producers now see their farm returns as being $130 (all from the market). Their total farm gate returns which were $164 now fall to $130 (a 21% decline).

The CRAM model accounts for total returns to producers with market returns being separately treated as that of subsidy payments. A price of $130 is set as the return to producers from the market and direct subsidy payments are set at zero. Similar calculations apply to each of the commodities listed in Table 3.1.

The changes in farm gate prices (columns c and e) in Table 3.1 are incorporated relatively easily into the model in the case of grains and oilseeds. Market prices for wheat are increased by 9%, barley by 1%, corn by 20%, canola by 1%; however, soybean and flax prices decline by 7% and 4%, respectively. These changes are merely shown as changes in the product prices.

In the case of beef and pork Canadian producers are facing world market prices approximately 10% higher than in the base case. These market price changes are incorporated through the retention function as a movement along the function. These producers also face higher feed prices and these changes are also specified in the retention function. In Western Canada barley prices are increased by 1.5% but in Eastern Canada, based on the expected increase in corn prices, a 24% change is specified.

Table 3.2 shows changes expected in dairy product prices. SWOPSIM changes in world prices, are 71%, 39% and 55% for butter, cheese and skim milk powder respectively. Butter prices in the U.S. are reported to remain at about $3500 per tonne for the base and policy scenario, cheese prices increase by about 3% and powder prices by about 33%. In Canada, it is reported that butter prices remain relatively constant at about CDN $4700/ tonne, powder prices increase by about 32%, but cheese prices decrease from $4650 to $2848 per tonne, which is counterintuitive because the world cheese price change is positive. In light of this result, Canadian cheese prices are kept constant in this study more in line with changes noted in the U.S.

Adjustments also needed in the poultry sector. It is assumed that the supply price of producers in each of the provinces, as defined earlier, is known. Canadian broiler and turkey meat prices, as reported in the SWOPSIM results (Table 3.1) are expected

Table 3.2: The Dairy Sector: SWOPSIM Results for Free Trade Scenario (1986) (1$US = 1.3895 $ CDN)

		Butter	Cheese	Powder
World Prices ($U.S.)	Base	2048	2744	1984
	Free Trade	3500	3831	3070
		(71)[a/]	(39)	(55)
U.S. Prices ($U.S.)	Base	3509	3730	2307
	Free Trade	3500	3831	3070
		(0)	(3)	(33)
Canadian Prices ($U.S.)	Base	3383	3347	2008
	Free Trade	3329	2050	2651
		(-2)	(-39)	(32)
Canadian Prices ($CDN)	Base	4700	4650	2790
	Free Trade	4625	2848	3683
		(-2)	(-39)	(32)
Offer to Purchase Price ($CDN)		4970	5050	

Source: IATRC, 1988
[a/] % change shown in brackets

to increase by 14% while egg prices decrease by 10%. These are changes that can be expected in current farm gate prices.

In the supply controlled industries it is assumed that producer quotas are eliminated. Hence, producers will expand or contract along their supply function to the point where marginal revenue is equal to marginal cost. Since the current supply price is generally below the new farm gate price level, one may expect an expansion in the size of these industries. Producers will expand along their supply curves from their current supply price positions to the new farm gate price levels.

The exact magnitude of these changes is shown for the poultry sector, on a provincial basis, in Table 3.3. As an example, take the broiler sector in B.C. — it is shown that producers will, under this policy change, receive a price of $1.28 for their product. Their supply price is calculated as $0.87/kg and therefore producers will expand along their supply curve to a new equilibrium.

In general, the changes noted are significant with producers in B.C. and Ontario, being the low cost producers, facing differences of up to 47% and 40%. In the prairie provinces the changes noted average 24% and in Quebec 31%. Similar patterns are noted for turkeys.

For eggs, where the market price is expected to fall by 10%, one still finds that with the exception of the Maritimes supply prices are significantly lower than this new trade equilibrium price. British Columbia and Ontario producers are expected to increase production significantly (51% and 41%), Quebec (27%) to a lesser degree, the prairie provinces fall behind Quebec in

Table 3.3: Supply Prices and Free Trade Prices for the Poultry Sector

	BROILERS			TURKEYS			EGGS		
	Supply Price ($/kg)	Free Trade Price ($/kg)	% Change	Supply Price ($/kg)	Free Trade Price ($/kg)	% Change	Supply Price ($/doz)	Free Trade Price ($/doz)	% Change
B.C.	.87	1.28	47	1.37	1.73	27	.56	.85	51
ALTA	1.02	1.27	25	1.38	1.75	27	.73	.82	12
SASK	1.00	1.25	24	1.37	1.74	27	.78	.81	3
MAN	1.00	1.22	22	1.30	1.64	26	.63	.76	21
ONT	.89	1.25	40	1.13	1.62	43	.58	.82	41
QUE	.94	1.23	31	1.24	1.60	29	.66	.84	27
MARITIMES	1.11	1.31	18	1.51	1.74	15	.99	.88	-11

a/ An upward adjustment of 8% in supply price estimates as provided by Meilke has been made.

expected output changes and in the Maritimes production will decrease (the farm gate price is less than the supply price). The exact change in production levels is also dependent upon the assumed price elasticities of supply for these sectors and upon the feed price changes.

Similar calculations are noted in the case of the dairy sector except that, with given world skim milk powder and butter prices, one needs to calculate the value of these products at the farm one needs to calculate the value of these products at the farm gate. It is assumed that fresh milk itself will be valued at the same price as the value of these products. In Table 3.4 supply

Table 3.4: Supply Prices and Farm Gate Product Prices for the Dairy Sector under Free Trade, by Province

Province	Supply Price ($/HL)	Free Trade Price ($/HL)	% Change
BC	30.18	44.11	46
ALTA	34.76	44.11	27
SASK	36.17	45.21	25
MAN	32.62	44.40	36
ONT	32.60	45.35	39
QUE	31.58	44.94	42
MARITIMES	34.14	42.73	25

prices, producer prices, and the changes are shown. The difference in B.C. between the current supply price and the new farm gate milk price is $13.93/hl. The product price is 46% higher than the supply price and producers, under a situation where supply is not controlled, will expand along their supply curve. In Quebec this difference is 42% and 39% for Ontario producers. The product price change averages 29% for the Prairie provinces. The significant differences between supply prices and farm gate prices imply that this industry will expand. A supply elasticity of 1.0 is used but, once again, feed price increases will dampen the own price effect.

SECTION 4

RESULTS

The results of this study are presented in this section. Changes in the dairy and poultry sectors expected under a free trade scenario are presented in detail. However, since the CRAM model also includes the grain and oilseeds crop sectors, the beef and hog sectors, changes in earnings for producers in these sectors, on a provincial basis, are also reported. Under this free trade scenario, producers in general observe higher market prices. However, the increase in market returns is offset by the complete elimination of all government assistance payments. The net impact of these changes is reported in this section.

4.1 <u>The Dairy Sector</u>

Changes expected in the dairy sector are examined first at the farm level where production and producer earnings changes are noted and second at the processing level where market demands at both the national and international level influence processors behaviour and returns.

4.1.1 The Farm Level

Recall that under a free trade scenario, producers are expected to increase their production from their current output levels to a point where marginal costs equal marginal revenue. For example, in Table 3.4 it was shown that for British Columbia and Quebec the difference between the estimated supply price under supply control and the free trade price was 46% and 42% respectively. Table 4.1 details the resulting farm level changes.

Table 4.1: Changes in Dairy Cow Numbers and Production Levels Under the Free Trade Scenario, By Province

Province	BASE No. of Cows (000' hd)	BASE Production (000' Hl)	FREE TRADE No. of Cows (000' hd)	FREE TRADE Production (000' Hl)
B.C.	83.0	4,897	120.8 (46)[a/]	7,128 (46)
Alberta	130.0	5,850	164.6 (27)	7,405 (27)
Sask.	59.0	2,242	73.5 (25)	2,792 (25)
Manitoba	71.0	2,911	96.2 (35)	3,944 (35)
Ontario	503.0	28,144	662.7 (32)	31,810 (32)
Quebec	615.0	28,290	828.8 (35)	38,127 (35)
Maritimes	86.4	4,320	101.8 (18)	5,088 (18)
Canada	1547.4	72,654	2048.4 (32)	96,294 (32)

[a/] % changes shown in brackets

Both cow herd numbers and milk output increases by 32% at the national level due to free trade (Table 4.1). However, this change is distributed unevenly between provinces. British Columbia increases output the most (46%), whereas the smallest increase occurs in the Maritimes (18%). These output and cow number changes are based upon an assumed supply elasticity of 1.0 which, in the absence of better information, is held constant across all provinces.

Any change in production levels will result in a change in producer earnings. Table 4.2 compares the gross and net sector earnings of the base and free trade scenarios. In the base case, national level gross earnings for the sector, including a subsidy payment of $275 million, are estimated to be $4.1 billion. Deducting cash production costs and feed costs of $1.4 billion, and a levy paid by producers of $247 million results in estimated net sector earnings of $2.4 billion. Similar estimates are provided for each of the provinces. Notice that together Quebec and Ontario account for 73% of all gross earnings, with B.C. and Alberta accounting for a further 13%.

Under a free trade scenario it is expected that gross earnings of dairy farmers will increase by 28% and net earnings will increase by 38%. However, again the increases in earnings are distributed unevenly between provinces. Gross earnings of producers in B.C. increase by 38% and their net is up by 45%, in

Table 4.2: Changes in Producer Earnings for Dairy Sector Under the Free Trade Scenario, by Province (m.$)

	BASE					FREE TRADE		
Province	Gross Income	Subsidy	Cash and Feed Costs	Levy	Net Earnings	Gross Income	Cash and Feed Costs	Net Earnings
B.C.	275.8	10.4	79.6	11.8	184.4[a/]	381.7 (38)[b/]	113.9 (43)	267.8 (45)
Alberta	300.2	18.7	105.4	22.7	172.1	385.6 (28)	133.4 (27)	252.3 (47)
Sask.	120.9	7.3	49.2	8.4	63.7	145.8 (21)	60.9 (24)	84.8 (33)
Manitoba	154.8	10.7	61.2	7.9	85.6	202.5 (31)	82.8 (35)	119.7 (40)
Ontario	1411.5	86.1	498.4	71.4	841.7	1770.0 (25)	665.1 (33)	1105.2 (31)
Quebec	1601.0	129.3	540.3	112.1	948.6	2096.9 (31)	743.3 (38)	1353.6 (43)
Maritimes	229.8	12.5	75.7	13.1	141.0	266.2 (16)	92.3 (22)	173.9 (23)
Canada	4094.0	275.0	1409.8	247.4	2437.1	5248.7 (28)	1891.7 (34)	3357.3 (38)

a/ Net Earnings includes veal income
b/ % changes shown in brackets

Quebec the change is 31% and 43% respec-tively, and in Ontario 25% and 31%.

Recall that these results are based on changes in world price levels for butter, cheese and skim milk powder as reported in Table

3.2. World prices for these three products were reported to increase by 71%, 39% and 55%, respectively. Despite these changes, butter and cheese prices for Canadian producers are held constant at their current levels; however, skim milk powder prices were increased by 32%. Under this scenario, producer gross and net income earnings are expected to increase, even though the fluid premium is lost. Therefore, dairy farmers, in general, will benefit by a move towards free trade.

Finally, a word of caution. It should be noted that these results represent merely one scenario given one set of exogenous world prices. The authors of this report have questioned some of the SWOPSIM model results and, therefore, must be interperted with care.

4.1.2 The Dairy Processing Level

Under the trade scenario examined in this study it is assumed that farm level production increases will be marketed domestically as either fresh or industrial milk. Industrial milk may be manufactured into cheese, butter, skim milk powder or other products. Export and import prices are set exogenously at world price levels which governs the level and direction of trade between Canada and other countries. Interprovincial trade, based on relative market and cost conditions, is also permitted under this scenario. The raw milk production increase of 32% is mainly absorbed by a 106% increase in butter production and by a 272%

increase in the amount of skim milk powder manufactured and sold (Table 4.3).[1] However, changes in fresh or low fat milk marketings are minimal. Standard milk marketings increase by 1%, and those of low fat milk by 4%.

Table 4.4 indicates the changes in value added in the dairy sector. The value added component of all processed dairy products changes from $518 million to $636 million; a 23% change in this value added activity. However, the value added component of fresh and low fat milk marketing activities (fluid milk) falls by 7%. At the different provincial levels, there are fairly significant differences in the change in value added. In general, the value added activity from fluid milk marketing declines in the free trade scenario and increases for the processed products. When both the fluid and manufactured product activities are aggregated the net change in value added activities at the national level is minimal. This is because, price changes for other products do not change significantly. In the case of fresh milk, an increase in the amount marketed results in lower product prices. The results in Table 4.4 show that B.C., Ontario and Manitoba processors benefit slightly under the new marketing environment while processors in Alberta, Saskatchewan and the Maritimes lose a small amount. In Quebec the change is minimal.

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[1] Due to a problem with the reported price of cheese and its related processing margin, cheese production was held constant in this scenario.

Table 4.3: Changes in the Dairy Processing Sector Production Levels under Liberalization, by province

	BASE						FREE TRADE					
	Total Milk Supplied	Standard Milk	Low Fat	Cheese	Butter	Powder	Total Milk Supplied	Standard Milk	Low Fat Milk	Cheese	Butter	Powder
	-------- (000 hl) --------			------ (tonnes) --------			-----------(000' hl) ----------			------- (tonnes) --------		
B.C.	4897	829	1886	11057	4847	5107	7128 (46)[a/]	850 (3)	1999 (6)	11057 (0)	7865 (62)	10989 (115)
ALTA	5850	546	1784	24880	6773	4190	7405 (27)	560 (3)	1891 (6)	24880 (0)	7287 (8)	3522 (-16)
SASK	2242	226	714	8403	2980	1833	2792 (25)	232 (3)	756 (6)	8403 (0)	3392 (14)	1541 (-16)
MAN	2911	283	714	10503	4065	1964	3944 (36)	290 (3)	756 (6)	10503 (0)	4629 (14)	1651 (-16)
ONT	24144	1906	7498	82589	32217	40259	31810 (32)	1915 (1)	7728 (3)	82589 (0)	61671 (70)	85178 (111)
QUE	28290	2803	3565	75322	39897	54273	38127 (35)	2815 (0)	3674 (3)	75322 (0)	107522 (170)	197439 (264)
MARITIMES	4320	897	1229	14117	5347	4167	5088 (18)	901 (0)	1267 (3)	14117 (0)	5696 (7)	3503 (-16)
CANADA	72654	7490	17390	226871	96146	111793	96294 (33)	7563 (1)	18071 (4)	226871 (0)	198062 (106)	303823 (272)

a/ % changes in parentheses

Table 4.4: Changes in Value Added in the Dairy Processing Sector Under Liberalization, by Province (m. $)

	BASE			FREE TRADE		
Province	Fluid Milk	Processed Items	Total Value Added[a]	Fluid Milk	Processed Items	Total Value Added[a]
B.C.	189.2	23.3	212.5	176.6 (-7)[b]	56.7 (143)	233.3 (10)
Alberta	165.1	46.4	211.5	140.9 (-15)	50.1 (8)	191.0 (-10)
Sask.	62.5	16.5	79.0	55.2 (-12)	22.4 (36)	77.6 (-2)
Manitoba	66.2	20.0	86.2	60.2 (-9)	37.8 (89)	98.0 (14)
Ontario	597.5	134.5	732.0	567.3 (-5)	209.8 (56)	777.1 (6)
Quebec	401.6	251.2	652.8	379.5 (-6)	274.7 (9)	654.2 (0)
Maritimes	124.5	26.5	151.0	117.6 (-6)	-15.3 (-158)	101.3 (-33)
Canada	1606.9	518.4	2125.3	1497.3 (-7)	636.2 (23)	2133.5 (0)

a/ Value added is calculated as the value of products sold less cost of raw materials and margin costs. Costs of manufacturing have not been included.

b/ % changes shown in brackets.

In summary it appears that dairy farmers themselves will benefit most by changes reported in this study. Value added changes in the processing sector are not significant. Increased production levels are also partly absorbed in the fresh milk and butter markets through lower prices and increased marketings of these products and therefore consumers benefit.

4.2 The Poultry Sector

It is anticipated that the poultry industry will experience significant changes under a liberalized trade scenario. Producers are expected to expand production because of assumed removal of producer quotas and the fact that price in most provinces is below the liberalized trade prices predicted by the SWOPSIM model. Changes in flock sizes, production levels and earnings are reported in the following three tables.

Table 4.5: Changes in Flock Sizes in the Poultry Sector, by Province (000' birds)

	Base Flock Sizes			Free Trade Flock Sizes		
Province	Broilers	Turkeys	Layers	Broilers	Turkeys	Layers
B.C.	33,980	1,570	2,730	44,540 (31)	2,180 (39)	3,810 (40)
Alberta	30,710	1,420	2,300	34,820 (13)	1,980 (39)	2,390 (4)
Sask.	8,940	350	1,100	10,070 (13)	490 (40)	1,060 (-4)
Manitoba	14,520	1,260	2,480	16,120 (11)	1,740 (38)	2,790 (13)
Ontario	120,840	7,060	8,990	138,100 (14)	10,960 (55)	10,720 (19)
Quebec	98,140	4,550	3,820	105,080 (7)	5,990 (32)	4,070 (7)
Maritimes	26,670	780	1,950	25,800 (4)	840 (8)	1,410 (-28)
Canada	333,800	16,990	23,370	374,530 (12)	26,250 (42)	26,250 (12)

Table 4.5 shows the flock size change for the broiler, turkey and eggs (layer) sectors. At the national level, there will be about a 12% increase in the size of the broiler and layer flocks and a 42% increase in the size of the turkey sector. On a provincial basis, there are wide variations in the flock size increase. The greatest increase occurs in B.C. for broilers and layers (31 percent and 40 percent, respectively), and in Ontario for turkeys (55 percent). For all three sectors, the Maritimes flock size changes are the lowest; for broilers the increase is 4%, for turkeys the increase is 8% and the layers flock size actually declines by 28%.

Table 4.6 shows the changes in production level. It is estimated that at the national level, broiler and layer output levels will increase by 14 and 15% respectively and turkey meat production will increase by 46%. The elasticity of supply for the turkey sector is 1.7 while that for the broiler sector is 0.8, which explains why the changes in the turkey sector are larger. Ontario experiences the largest increase in the turkey meat production (58%) while B.C. has the largest production increases in broilers and eggs (31% and 40%). The Maritimes again suffer only small increase (9% in turkey meat production) and a reduction in broiler and egg production (-1% and -26%). The slight differences between percentage increases in flock sizes and production levels is explained by different production level per bird.

Table 4.6: Changes in Production Levels for the Poultry Sector Under Liberalized Trade

Province	Base Situation			Liberalized Trade		
	Broilers (000' t)	Turkeys (000't)	Layers (m.doz)	Broilers (000't)	Turkeys (000't)	Layers (m.doz)
B.C.	49.2	10.0	54.3	65.6 (33)	14.2 (42)	77.0 (42)
Alberta	39.8	9.4	40.2	46.0 (16)	13.3 (41)	42.6 (6)
Sask.	11.9	2.5	18.6	13.7 (15)	3.5 (40)	18.2 (-2)
Manitoba	19.3	8.7	48.5	21.8 (13)	12.1 (39)	55.5 (14)
Ontario	171.0	46.6	181.4	199.0 (16)	73.6 (58)	220.0 (21)
Quebec	149.6	24.2	74.5	163.1 (9)	32.7 (35)	80.9 (9)
Maritimes	36.5	3.2	37.1	36.0 (-1)	3.5 (9)	27.4 (-26)
Canada	477.3	104.6	454.6	545.2 (14)	152.7 (46)	521.7 (15)

Gross earnings changes to each of these industries varies as indicated in Table 4.7. Broiler sector gross earnings increase by 19%, those to the turkeys sector by 52% and there is a 1% change in layer gross earnings. As noted earlier egg prices at the farm gate level fall relative to the base but producers expand output because controls are removed. In aggregate the change in net sector earnings for the poultry industry is from $534 million to $548 million. The poultry sector as a whole benefits under trade liberalization with a net increase in sector earnings of approximately 3%.

Table 4.7: Changes in Poultry Sector Earnings Under Liberalization, by Province (m. $)

	BASE				FREE TRADE			
	Gross Earnings			Net Sector Earnings	Gross Earnings			Net Sector Earnings
Province	Broilers	Turkeys	Eggs		Broilers	Turkeys	Eggs	
B.C.	57.4	15.0	51.4	62.1	75.9 (32)	21.4 (43)	65.3 (27)	75.3 (21)
Alberta	46.5	14.1	38.1	48.2	53.2 (14)	20.1 (43)	36.1 (-5)	50.1 (31)
Sask.	13.9	3.7	17.6	16.5	15.8 (14)	5.3 (43)	15.4 (-13)	15.7 (-5)
Manitoba	22.5	13.0	46.0	41.1	25.2 (12)	18.4 (42)	47.1 (2)	41.9 (2)
Ontario	186.3	66.8	181.7	200.5	230.1 (24)	111.2 (66)	192.5 (6)	208.6 (4)
Quebec	163.0	35.0	74.7	131.2	188.6 (16)	49.4 (41)	70.8 (-5)	131.6 (0)
Maritimes	39.8	4.6	37.2	34.6	41.6 (5)	5.3 (15)	23.9 (-36)	25.3 (-27)
Canada	529.4	152.2	446.7	534.2	630.4 (19)	231.1 (52)	451.1 (1)	548.5 (3)

Gross sector earnings change from $1.13 billion to $1.31 billion. Although gross earnings to the sector increase by 16% net sector earnings increase by 3%. The increase in gross earnings is similar to the increase in output levels for the broiler and layer sectors but after changes in feed costs are accounted for, especially in Eastern Canada, net sector earnings are only up 3%.

These results need to be evaluated fairly closely for their policy implications. Under the scenarios examined it is reported that at the national level producer incomes are not expected to fall. Although some provinces gain more than others and there are net sector losses in the case of Saskatchewan and the Maritimes.

The poultry sector in these provinces do appear to be well positioned should a move towards a freer trading environment be considered.

It is difficult to know what changes in the structure of the industry may be expected. Under the scenario examined and with a removal of quota controls there is an expansion of output levels for both broiler and turkey meats and eggs. In the case of eggs the 15% increase in production is marketed at a lower price and hence gross earnings increase by only 1% (from $447 million to $451million). Production increases in poultry meats are marketed at higher prices and gross earnings to the broiler sector increase by 19% while those of the turkey sector increase by 52%. It could be hypothesized that with the removal of controls there will be a tendency for larger producers and perhaps larger producing provinces to become dominant in the industry as the analysis assumes that regulations which set a maximum on farm size would be removed. Some fairly significant changes may also be expected in the structure of the processing sector.

Gross sector earnings increase by 66% for Ontario, by 43% for the Prairies and B.C. and by 15% for the Maritimes. These changes are fairly significant and hence turkey producers benefit proportionately more than broiler and layer producers and Ontario gains most. The increase in gross sector earnings in Ontario is 66% for the turkey sector and 24% for the broiler sector. In this study turkey meats are not treated separately from that of chicken meats. Hence, an elimination of trade barriers has important effects on the gross sector earnings of poultry producers in Canada and if these estimates are correct the changes noted may also impact upon regional and other markets.

Changes expected in the layer sector vary quite widely by province. Flock size changes vary from a 40% increase in B.C. to a 28% decrease in the Maritimes (Table 4.5). In Alberta there is a 4% increase, a 4% decrease in Saskatchewan, a 13% increase in Manitoba, 19% increase in Ontario and a 7% increase in the Quebec. Gross sector earnings increase by 27% in B.C., they fall in Alberta and Saskatchewan by 5% and 13% respectively, they increase in Manitoba by 2% and increase by 6% in Ontario. In Quebec, earnings fall by 5% and they are down 36% in the Maritimes. Hence, B.C. benefits most under this scenario while producers in Alberta, Saskatchewan, Quebec and the Maritimes may expect a decrease in their gross sector earnings. Again, as with chicken and turkey meats, no distinction is made between the fresh and breaker egg markets. The model does not specify different provincial or international demands for these two products. Shifting regional production patterns have different implications for the processing and marketing segments of this industry.

The processing sector of the broiler and egg markets have not been specified in this study, nor have demand functions for different poultry products been specified. The analysis has also not distinguished between different world and regional markets for different processed items. However, it is in these markets that many of the "world" trade prices referred to earlier are determined. It is, therefore, often important that one disaggregate primary production and commodities to the farm in which most trade prices are established but there are conceptual and empirical problems in doing so. For example, it becomes necessary to consider whether certain provinces would become dominant in the processing sector because of economies of scale or size and whether or not changes may be expected in the structure of the industry under a situation where provincial production share controls are removed. These aspects require special attention and are outside the bounds of this study. The changes noted should be evaluated within the context of these limitations.

4.3 The Crop and Grains Sector

Under the trade liberalization scenario world prices for wheat, coarse grains and corn will increase by 29%, 20% and 24% respectively. It was indicated earlier that Canadian wheat producers received $117/tonne from the market plus another $47/tonne in the form of direct payments (1986-87). Hence, producer returns are $164/tonne if market returns and direct payments are included. The SWOPSIM results show that market returns to Canadian producers under the trade liberalization scenario increase from $117 to $130 per tonne. However, gross receipts from both the market and direct payments decrease from $164 to $130/tonne as improved market returns are insufficient to offset the elimination of all direct payments. As shown in Table 3.3 coarse grain producers receive an extra $1/tonne from the market but direct payments are reduced by $27/tonne. Corn prices increase by $21/tonne from a base of $87 due to strengthening world prices but the loss of direct payments of $25 and other "wedge" benefits result in producers facing a 4% decline in farm gate returns. Hence, although market returns increase gross returns to grain producers are expected to fall under this free trade scenario. These results are summarized in Table 4.8.

Gross farm value of all grain produced in the base case is estimated at $8.8 billion. Receipts from the market alone are $7.1 billion and an additional $1.7 billion is from the government. Nineteen percent of all receipts are in the form of direct assistance payments. Under the trade liberalization scenario gross farm receipts fall to $8.2 billion from $8.8 billion (a 7% decline). Market returns in the base case are $7.1 billion. Hence, although returns from the market increase, the increase is insufficient to offset the loss in direct and indirect payments from government and producers face a 7% decline in net sector earnings. In the Prairies, gross returns to producers in the base case are $6.4 billion. They fall to $5.87 billion in the free trade scenario.

Table 4.8 Changes in Earnings for the Crop and Grain Sector Under The Trade Liberalization Scenario (m. $)

	Gross Farm Returns				Cash Costs		Net Sector Earnings Including DFTs in the Base Case	
	BASE							
Province	Market	DFTs	Total	Free Trade	Base	Free Trade	Base	Free Trade
B.C.	78.2	17.9	96.1	90.4 (-6)[a/]	50.3	50.5 (0)	45.8	39.9 (-13)
ALTA	1615.9	522.1	2138.0	1957.9 (-8)	1129.7	1106.7 (-3)	998.3	851.2 (-15)
SASK	2287.3	734.7	3022.0	2869.9 (-6)	1540.2	1459.4 (-5)	1481.8	1370.5 (-8)
MAN	967.9	235.9	1203.8	1041.0 (-14)	750.3	657.1 (-12)	453.5	383.9 (-15)
ONT	1547.2	105.4	1712.6	1669.2 (-3)	996.3	999.4 (0)	716.3	669.8 (-6)
QUE	263.2	88.9	302.1	302.4 (0)	238.7	242.7 (2)	63.4	59.7 (-6)
MARIT.	298.4	4.9	303.3	303.8 (0)	163.4	163.6 (0)	139.9	140.2 (0)
CANADA	7058.1	1719.8	8777.9	8194.6 (-7)	4878.9	4679.4 (-4)	3889.0	3515.2 (-10)

a/ % changes in parenthesis

Net farm sector earnings from all sources is calculated as gross returns less cash costs. In the base case when government payments are included total net receipts are $3.9 billion. These fall to $3.5 billion in the trade liberalization scenario and therefore producer sector earnings decline by 10%. The average decline for prairie producers is 15% while in Eastern Canada it averages out at about 5%. In the base Eastern Canada producers received proportionately less in the way of direct financial transfers. The higher transport costs faced by prairie producers also does not effect them as much.

For grain producers, the increase in commodity prices is insufficient to compensate for the loss in direct assistance and other payments from government and producers of this sector will not benefit under a freer trading environment. Government budget expenditures will, however, fall by $1.7 billion in direct assistance payments and with compensatory rail rates, the elimination of pool deficits and crop insurance coverage costs there will be an additional savings to government of approximately $2.8 billion.

Consider a base in which farm returns from the market only are considered, that is, government payments are excluded. It is shown in Table 4.9 that market returns are $7.1 billion. Under the free trade scenario market returns increase because of higher prices and hence producer returns increase by 16% to $8.2 billion. Net farm sector earnings are $2.2 billion in the base and these increase to $3.5 billion, a 70% increase. Net sector returns to Prairie producers average 79% more.

In summary, these results show that net farm returns to the crop and grains sector decline by $0.37 billion, from $3.88 billion to $3.51 billion. In the base case where 19% of gross farm returns are in the form of government assistance payments, a total of $1.7

Table 4.9 Changes in Grain Sector Showing Market Returns Only Under Trade Liberalization Which Excludes all Government Payments in the BASE Situation[a] (m. $)

Province	Gross Farm Returns to Producers		Net Sector Earnings Excluding DFTs in the Base Case	
	BASE	FREE TRADE	BASE	FREE TRADE
B.C.	78.2	90.4 (16)[b]	27.9	39.9 (43)
ALTA	1615.9	1957.9 (21)	476.2	851.2 (79)
SASK	2287.3	2829.9 (24)	747.1	1370.5 (83)
MAN	967.9	1041.0 (8)	217.6	383.9 (76)
ONT	1547.7	1669.2 (8)	610.9	669.8 (10)
QUE	263.2	302.1 (15)	24.5	59.7 (143)
MARITIMES	298.4	303.8 (2)	135.0	140.2 (4)
CANADA	7058.1	8194.6	2239.2	3515.2

a/ Other implicit indirect "wedge" payments such as WGTA, pool deficits and Crop Insurance are included in the BASE.

b/ % Changes in parenthesis

billion is paid to producers. The tradeoff involved is a loss in net returns to producers of $0.37 billion but a decrease in direct government assistance payments of $1.7 billion. In addition, indirect or other assistance payments which amount to approximately $2.8 billion are also saved for the taxpayer.

4.4 The Beef Sector

Under trade liberalization cow-calf operators face market prices that on average increase by 10%. Producers will respond to this higher price by increasing the size of their herds. However, on the negative side with trade liberalization feed grain prices increase by 1.5% for Western Canada and by 24% for Eastern Canadian cow-calf producers and feeders. Hence, producers will respond to this increase in feed costs by reducing herd sizes. In addition, under a trade liberalization scenario it is assumed that all direct assistance payments to producers by governments are eliminated. According to Webber et al. (1988) one needs to recognize that producers in different provinces receive differing amounts of support and if these are removed cow herds will be reduced.

Results are reported in Table 4.10. The impacts of these changes on cow herd sizes in each of the provinces are indicated and the change in output of high quality beef from this sector and change in beef sector earnings are noted. It is shown that at the national level the size of the cow herd is unchanged. There are some provinces (Saskatchewan and Manitoba) where the net effect of these changes is positive and for other provinces the change is negative. In particular, Quebec cow-calf is reduced by 8% due to the fact that assistance levels to producers in this province are the highest of all provinces.

Although cow number changes are fairly small it is noted in Table 4.10 that the total quantity of high quality beef produced increases by 11%. Each of the provinces show fairly significant increases in the amount of high quality beef produced and beef sector earnings increase by 8%. This change is explained by the number of dairy calves that transfer to the beef sector for finishing. It was shown earlier that there is a substantial increase in the number of dairy cows and therefore culled calves will be transferred to the beef sector. In B.C. there is a 24% increase in this transfer, 10% for Alberta, 4% for Saskatchewan, 11% for Manitoba, 8% for Ontario and a 53% increase for Quebec. The change in the amount of high quality beef produced averages about 6% for the Prairies, it is up 3% in Ontario, up 27% in British Columbia and the production increases from 19 thousand tonnes in Quebec to 52 thousand tonnes. In total the net change in Canada is from 594 thousand to 662 thousand tonnes.

Table 4.10: Changes in Beef Sector Herd Sizes, Production Levels and Net Sector Earnings under Free Trade Scenario, by Province

Province	Cows and Replacements (000 head)		High Quality Beef Production (000 m.t.)		Net Beef Sector Earnings (m $)	
	Base	Free Trade	Base	Free Trade	Base	Free Trade
B.C.	217	215 (-1%)[a/]	20.8	26.4 (27)	58.4	50.6 (-13)
ALTA	1268	1271 (0)	254.5	269.5 (6)	500.2	551.5 (10)
SASK	871	892 (2)	58.3	61.9 (6)	179.2	189.8 (6)
MAN	380	384 (1)	67.1	72.5 (8)	133.6	143.0 (7)
ONT	418	411 (-2)	159.7	164.3 (3)	235.5	249.8 (6)
QUE	202	185 (-8)	19.7	52.1 (165)	77.9	97.5 (25)
MARITIMES	71	69 (-3)	14.2	15.7 (10)	24.7	28.3 (15)
CANADA	3427	3424 (0)	594.3	662.4 (11)	1209.5	1310.5 (8)

a/ % changes in parentheses

Changes in net sector earnings are shown in Table 4.10. Sector earnings are calculated as total revenue less total variable costs. The value of each provincial sector's output is adjusted for changes in the values of inventories, for transfers to the dairy sector and for the value of live animals and products shipped out of province or to exports. Cash production costs, feed costs and the value of shipments into a province, including transport costs, are treated as costs. It is shown that sector earnings increase by 8% for Canada, those of the Prairie provinces increase by 8%, Ontario's earnings increase by 6%, those of Quebec by 25% and B.C.'s decrease by -13%. Beef producers therefore benefit from a move towards free trade, mainly due to the fact that a greater number of surplus dairy calves are available for transfer through to the feeding sector.

4.5 The Hog Sector

Impacts of this trade liberalization scenario in the hog sector are reported in Table 4.11. At the national level producer prices change from $1,793/tonne to $1,967/tonne, a 10% increase. However, direct payments to producers of $23/tonne are eliminated and, in addition, producers face higher feed prices. In the West, feed prices are up 1.5% but, in the East, they are increased by 24%. These changes are incorporated into the retention functions for breeding sows and, as shown, the net impact of these changes is a 2% decline in sow numbers at the national level. There are variations in these changes between provinces; Manitoba increases its herd by 6% while Ontario and Quebec decrease theirs by 3%.

Table 4.11: Changes in Sow Numbers, Production Levels and Net Sector Earnings under Free Trade Scenario, by Province

Province	Sow Numbers (000 head)		Pork Production (000 m.t.)		Net Sector Earnings (m $)	
	Base	Free Trade	Base	Free Trade	Base	Free Trade
B.C.	26.5	26.9 (1)[a]	22.2	22.9 (1)	39.5	44.6 (13)
ALTA	145	145 (0)	129.0	131.0 (2)	233.6	259.6 (11)
SASK	68	66 (-3)	49.3	48.9 (0)	84.9	89.8 (6)
MAN	113	120.0 (6)	115.1	124.1 (8)	218.1	260.4 (19)
ONT	370.0	359.2 (-3)	292.6	288.5 (-1)	376.3	384.9 (2)
QUE	320.0	308.9 (-3)	300.6	294.7 (-2)	435.1	431.0 (-1)
MARITIMES	44.1	40.2 (-9)	38.3	35.5 (-7)	65.4	60.7 (-7)
CANADA	1086.6	1066.2 (-2)	947.1	945.6 (0)	1452.9	1531.0 (5)

a/ % changes in parentheses

Canadian production under this scenario remains relatively constant at 947,000 tonnes (Table 4.11) with B.C., Alberta and Manitoba increasing output levels and Ontario, Quebec and the Maritimes decreasing their output levels. As a result of these and other changes net sector earnings as shown in Table 4.11, at the national level, increase to $1.53 billion from $1.45 billion, a net change of 5%. In the East, where producers generally face higher feed costs, earnings changes are small, a 2% increase for Ontario and a decrease of 1% for Quebec producers. In the Prairies and B.C., the average increase in net sector earnings is about 12%.

In summary, hog producers in the western provinces benefit under this trade liberalization scenario while earnings of those in the eastern provinces remain relatively constant. In the base case $92 million is paid in the form of direct assistance from governments and with the elimination of all payments a budget saving of this amount is made under this trade scenario. Gross earnings in the base case are $1.9 billion and thus assistance payment account for about 5% of the total receipts of hog farmers.

In Table 4.12 changes in net trade levels for beef and pork sectors for the base and free trade scenario are reported. Canada increases its exports of high quality beef from 46,000 tonnes to 163,000 tonnes. Exports of pork increase by 18% from a base of 260,000 tonnes and net trade in feedlot calves and yearlings falls.

Table 4.12: Changes in Interprovincial Trade and Net Exports for Beef and Pork Sectors under Free Trade Scenario, by Province

Province	Feedlot Calves and Yearlings (000 head) Base	Feedlot Calves and Yearlings (000 head) Free Trade	High Quality Beef (000 m.t.) Base	High Quality Beef (000 m.t.) Free Trade	Hog Sector Dressed Pork (000 m.t.) $) Base	Hog Sector Dressed Pork (000 m.t.) $) Free Trade
B.C.	23.2	17.3 (-25)[a/]	-43.4	-32.9 (24)	-35.0	-29.0 (17)
ALTA	-87.6	-125.1 (-43)	202.0	220.9 (9)	39.1	45.8 (17)
SASK	336.5	340.2 (1)	35.9	41.3 (15)	23.3	24.8 (7)
MAN	-10.8	14.0 (-30)	43.1	50.5 (17)	79.6	90.6 (14)
ONT	-401.3	-340.8 (15)	-26.1	-2.2 (108)	16.1	28.6 (78)
QUE	125.3	105.3 (-16)	128.0	-82.5 (-164)	161.2	167.6 (4)
MARITIMES	5.8	4.9 (-16)	37.4	-32.1 (-186)	-23.9	-22.4 (6)
CANADA	-9	-12.2 (-36)	46.1	163.1 (354)	260.4	306.0 (18)

a/ % changes in parentheses

SECTION 5

SUMMARY

This study examines an extreme position of complete trade liberalization for OECD countries and measures some of the impacts of such a change upon producers' earnings for major agricultural commodities in Canada. The results provide some insights into changes that one may expect in Canadian agriculture as a move towards free trade is considered. As noted the study is exploratory in nature because information of quota values that are critical to this analysis is sparce. Given more accurate information on these values, the methodology and approach adopted in this study allows for an easy updating of the results reported.

This analysis shows that, with multilateral trade liberalization, Canadian producers of milk and poultry products can compete in the international market place. This would allow these industries an opportunity to expand. Under current controls, they are restricted to relatively stagnant domestic markets. British Columbia, Ontario and Quebec are the big gainers. In poultry, Ontario gains relative to Quebec but for dairy the reverse is true. Quebec is a relatively low cost producer of milk. With liberalization, world and domestic prices for industrial milk increase while fluid prices decrease and therefore Quebec producers who have historically geared their production to industrial milk gain relatively more.

A consideration involves the extent to which world price increases would change if the Canadian supply responses differs from those predicted by the SWOPSIM model. The SWOPSIM results underestimate the net export position for Canada reported for the supply managed industries and beef in this study. They are similar for wheat. Coarse grain net exports are less in this study, largely due to the expansion in dairy. Pork exports increase whereas in SWOPSIM they declined slightly. Overall, the differences are not expected to have a large impact on world prices which are taken as exogenous in this study.

The regional impacts reported vary significantly from the weighted national average impacts. Past distortions in feed grain pricing in Canada has had major implications, especially for western Canadian livestock producers.

Prairie grain growers do not see world prices rising sufficiently under liberalization to offset the combined loss of support they now receive from direct stabilization and deficiency payment programs and from indirect subsidy supports (mainly WGTA). Western red meat producers fare somewhat better under free trade although a strengthening of world prices are largely offset by a loss of direct government payments. The Maritimes is a region that does not fare well under liberalization. It is a grain deficit region and has received very high levels of support for red meats.

This analysis does not address the issue of future market price and income instability that may arise under liberalization with open borders. Although world prices would be more stable than they are currently, they may be less stable than currently achieved in our domestic markets under supply management. However, even under supply management, producers have not been totally immune from world market price changes. The levy on disposal of surplus skim milk powder over the last couple of years has fluctuated between \$3/hl and \$6/hl relative to target prices of \$45-47/hl.

In other studies of trade liberalization Canadian producers have generally been found to be slightly worse off relative to their current situation. Improvements in world prices under liberalized trade and reduced support have not been strong enough to fully compensate for the loss of income transfers currently obtained from government programs. In this analysis the opposite conclusion is reached. Although the grains and oilseeds sectors are slightly worse-off, the earnings for the other commodity sectors generally improve, especially in the dairy sector.

Overall, net sector earnings improved by close to $0.7 billion and to this has to be added significant budget savings. The question of just how competitive Canadian supply managed industries are under a liberalized market environment remains an open question but the possibility that Canadian dairy and poultry producers could compete at undistorted world market prices should not be dismissed out of hand. It would be necessary to expand upon the processing and marketing components of the poultry sectors if a more detailed analysis of this sector is to be attempted. Changes in the structure of this component of the industry are anticipated under a freer market environment.

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APPENDIX
MODELING SUPPLY RESPONSE POTENTIALS OF SUPPLY MANAGED INDUSTRIES: A METHODOLOGICAL APPRAISAL AND EMPIRICAL APPLICATION

PART 1: METHODOLOGICAL APPRAISAL

1. Introduction

Supply management refers to those regulatory activities of marketing boards that involve controlling the level of production and fixing the price paid to producers. Marketing boards are statutory, and typically compulsory, horizontal cartels of producers that have emerged as major institutional tools of agricultural policy in Canada at both the federal and provincial levels. While marketing boards engage in a variety of activities that have a pervasive influence on the working of the agri-food sector, the monopoly-monopsony power of supply management is a prerogative only of boards dealing with milk, poultry meat, eggs, and tobacco.[2]

Most of the studies on supply management have emphasized the welfare effects of this policy tool. The general conclusion is that this regulation gives rise to efficiency losses because the market clears at a point where the marginal benefit to consumers (as indicated by market price) differs from the marginal cost of

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[2] See Veeman and Loyns (1979) for an overview on Canadian marketing boards. A comprehensive description of structure, powers, and historical developments of Canadian marketing agencies and Ontario marketing boards is given by Lane (1982). Rules governing the movement of quotas from farm to farm for a number of boards are extensively documented in Barichello and Cunningham-Dunlop (1987).

production.[3]

Unlike other more transparent government programs, the extent of this departure from marginal cost pricing is not directly observable in the case of direct quantity restrictions. Also, the existence of unobserved departures from marginal cost pricing implies that observed prices are not relevant in guiding supply decisions, so that direct estimation of market supply response is rendered infeasible.

Information on the shape of the supply function of supply managed commodities, and on the departure from marginal cost pricing (the "location" of the supply curve), is however crucial in assessing the possible impacts of ongoing trade liberalization negotiations.

Given the above, the purpose of this paper is to review the conceptual issues relating to the specification and estimation of supply response models for industries subject to supply management schemes. A research strategy that will enable estimation of supply functions for supply managed commodities is outlined, and the informational requirement for a successful implementation of this research program is discussed.

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3 See, among others: Arcus, 1981; Barichello, 1982; Harling aand Thompson, 1983; Josling, 1981; Schmitz, 1983; and Veeman, 1982.

The paper is organized as follows. Section 2 provides an overview of supply management schemes in Canadian agriculture. Section 3 discusses the analysis of supply at the farm level. In particular, section 3.1 outlines research strategies to deal with the existence of production quotas, section 3.2 discusses some specific problems with using farm-level data, and section 3.3 deals with the analysis of industry supply response given farm-level estimates. Supply response analysis at the aggregate level is the subject of section 4, with section 4.1 specifically dealing with appropriate research strategies under supply management. Section 5 summarizes objectives and the main methodological conclusions of Part I. In Part II, section 6 describe a practical approach to positioning supply curves and in Section 7 relevant elasticities are discussed.

2. Supply Management in Canadian Agriculture: An Overview.

The production and marketing of milk provides a general example of supply management in Canadian agriculture, and a brief analysis of its structure is illuminating on the nature of this type of market regulation.[4] The policy setting distinguishes between industrial and fluid milk production. Industrial milk production is directly regulated at the federal level by the Canadian Dairy Commission, although the administration of the policy is a joint program that involves provincial governments and

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4 See Barichello (1981) and Stonehouse (1987) for more information on dairy industry policy.

provincial producers' marketing boards. The price of milk is set administratively on the basis of a returns adjustments formula, which reflects the cost of producing milk in terms of both direct cash costs and imputed returns to farmers' own resources. This target price is achieved through a direct federal subsidy to milk producers to top-up the price they receive from processing plants. The minimum price the latter have to pay for industrial milk is maintained through an offer-to-purchase scheme, by which the Canadian Dairy Commission is ready to buy butter and skim milk powder at set prices.

This system of price support is rendered viable by managing supply and, in a sense, demand. Total demand is managed by trade restrictions. Imports of cheese are permitted only up to a small import quota, whereas imports of other milk products are essentially prohibited. Trade restrictions extend to substitute products such as margarine and refined vegetable oils. These rigid trade restrictions allow an assessment of the production required to meet domestic demand at the set prices, and this production target is achieved through the allocation of market sharing quotas to each province and each licensed producer. Production in excess of this quota level is discouraged by high over-quota levies. The system generates a modest surplus of skim milk powder and evaporated milk, which is exported or used as food aid. The costs of the surplus disposal programs are mostly covered by an in-quota levy which is directly deducted from producer returns.

Fluid milk production is regulated at the provincial level by producer marketing boards under the supervision of provincial statutory regulatory agencies. A cost of production formula is used to set prices, which are administered as local monopoly prices in each province given that imports from the U.S. are banned and interprovincial trade is virtually precluded by complex health and licensing regulations. To allow the market to clear at the set price, production is restricted by producer quotas. Industrial and fluid milk quotas are formally the property of the provincial marketing boards, and allotted to individual producers solely for their use under the conditions specified by the board. In practice these conditions allow production quotas to be bought and sold, subject to approval rules that vary substantially by province so that this right to produce is best viewed as owned by the individual producers.

Arrangements similar to those just described for milk exist for broilers, turkeys, and eggs. Prices paid to producers are based on cost of production formulae for eggs and turkeys but involve market forces in the case of broilers. Import quotas are used to reserve most of the domestic market for Canadian production. To maintain the internal price structure, aggregate output is restricted to the amount estimated to be demanded at the administratively set prices through the use of production quotas allocated to each province and to each producer. Provincial marketing boards also set limits on the maximum size of production units, and set the rules that allow quotas to be transferred between producers within a province.

The tobacco industry is also subject to supply management, but its demand characteristics differ somewhat from other controlled commodities (Menzie and Marshall, 1981). Unlike milk, poultry meat, and eggs, a sizeable part of production (normally between one-third and one-half) is exported. Most of the production takes place in Ontario, and the provincial marketing board does not have the powers of a national agency. While imports are subject to a tariff, they are not quantitatively restricted. All this makes it very difficult for the board to price tobacco independently of market conditions. The board does set a minimum price, but the actual sale price is determined through auction exchanges operated by the board. Producers cannot market any tobacco in excess of the quotas allocated to them by the board, and these basic quotas can be transferred or rented.

3. Modeling individual farm supply response.

Before considering the effects of production quotas on individual supply response, it is useful to derive the basic analytics of individual supply response in the unconstrained case. Consider a farm producing the output y according to a neoclassical production function $y=f(x)$ where x denotes the input vector. A basic result of the duality approach to microeconomic theory (Varian, 1984; Chambers, 1988) is that, under cost minimization behaviour, the cost function $c(y,w)$ represents an alternative description of this production technology, where the cost function is defined as:

$$c(y,w) = \min_x \{wx : y \leq f(x)\} \quad (1)$$

with w being the input price vector. Given this setting, the supply response of the farm can be derived by extending the behavioral assumptions to profit maximization. Given an output price p, the profit function $\pi(p,w)$ is defined as:

$$\pi(p,w) = \max_y \{py - c(y,w)\} \quad (2)$$

Since agricultural production decisions are typically made before output price is known with certainty, it is better to think of p as representing the expected price. The supply function y(p,w) is immediately obtained from the profit function by Hotelling's lemma:

$$y(p,w) = \delta\pi/\delta p \quad (3)$$

Note that y(p,w) will solve the first order condition of problem (2), which is the familiar $p = \delta c/\delta y$. Comparative statics of this first order condition also reveals that:

$$\delta y/\delta p = [\delta^2 c/\delta y^2]^{-1} \quad (4)$$

that is, the slope of the supply function is the reciprocal of the slope of the marginal cost schedule. This is illustrated in Figure 1, where an output price of (say) p' will result in a profit maximizing level of output y'.

The econometric utilization of this framework of analysis is straightforward. Given a random sample of observations on (y,p,w) for the same farm, such as the dots dispersed around the supply curve in Figure 1, y(p,w) could be estimated. Standard specification issues would include the choice of a functional form, an explicit formulation of the output price expectation formation, and the specification of the stochastic process governing the randomness of the observations on (y,p,w).[5] Also, one may wish to account for risk-averse behaviour and for the dynamics introduced by rigidities in the utilization of some inputs. Abstracting from these last considerations, for the case of no production quotas, observations on output supply, input prices, and output prices should give enough information to estimate the supply response of the farm.

3.1 Individual farm response with production quotas

In this section we will make the simplifying assumption that quotas can be freely traded among producers. Also, assume that quotas could be rented at a price q (in other words, paying q gives the producer the right to produce one unit of y per one production period). Thus, the profit function (2) can be amended to:

$$\pi(p-q,w) = \max_{y} \{(p-q)y - c(y,w)\} \tag{5}$$

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[5] The issue of endogeneity of (p,w) should not arise at the individual supply level, unless some of the inputs are fixed but allocatable within the individual farm.

Figure 1 - Farm Output Supply

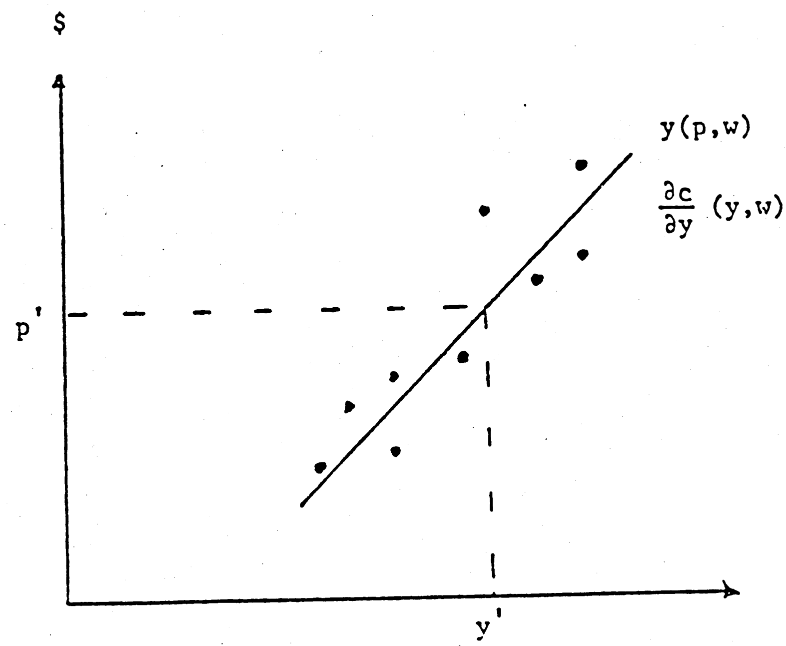
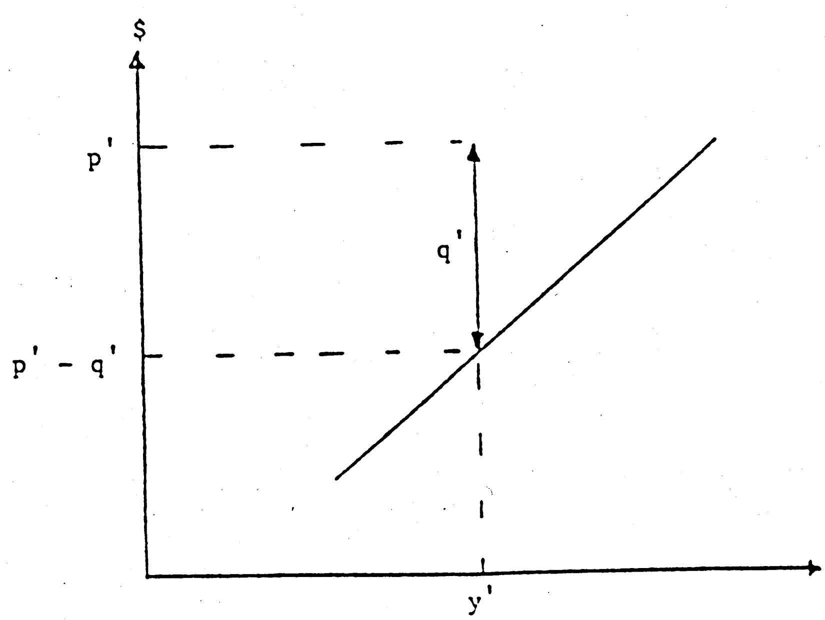


Figure 2 - Farm Output Supply with Production Quotas



Note that the first order condition for problem (5) requires:

(6) $$q = p - \delta c/\delta y$$

which illustrates that the quota rental price q equals the difference between price and marginal cost. This case is illustrated in Figure 2, where a price of p' and a quota price of q' would imply an optimal supply y'. Again, using the derivative property, the supply function y(p-q,w) can be derived from the profit function in (5):

(7) $$y(p-q,w) = \delta\pi/\delta p$$

Thus, it is apparent that the informational requirement to estimate supply response when quotas are effective is increased. If we wish to estimate y(.) directly, analogously to the previous section, we now need observations on (y,p,w,q). The problem, as mentioned in the introductory section, is that the rental price q is typically not observed, as quotas are traded as capital assets that give the right to produce and market output indefinitely.

To overcome this problem, two strategies could be pursued at the empirical level. First, one could exploit the duality between profit and cost function and estimate a marginal cost relationship instead of an output supply relationship. This strategy would require no information whatsoever on quota rental prices, and indeed this method would yield an estimate of q. In other words, we would be estimating the curve in Figure 2 taking values on the abscissa as given rather than the values on the ordinate. Given the assumptions made so far, the problem would be an econometric one. Since y is endogenous to the profit maximization process, a technique suitable for this case, such as instrumental variables, would be needed.

The second strategy involves finding an estimate of a q prior to estimating the supply response of the farm. An obvious avenue, in this case, is to exploit the information on the capital value of quotas, which is usually more easily obtainable. Given that quotas confer a right to produce (at privileged prices) that extends into the future, they can be viewed as an asset and their value will equal some discounted form of present and future returns, these returns being the difference between price and marginal cost (that is, q). If the asset value of quotas is known, in principle it is possible to recover from it the size of the departure from marginal cost pricing by using an appropriate discount rate. The problem, of course, is what discount rate should be used. Notionally, this discount rate should account for elements such as the risky nature of the asset, expected capital gains, expected nominal interest rates, and planning horizons.

This problem has been analyzed extensively. Barichello (1984a), and Lermer and Stanbury (1985), argue convincingly about the riskiness of quotas, with the latter authors emphasizing the risk introduced by the fact that this "right" to produce at privileged prices may be abolished by governmental decision. All this would suggest that an appropriate discount rate should account for a fairly high risk premium. Moschini and Meilke (1988) find empirical support for this contention for fluid milk quotas in Ontario, while industrial milk quotas displayed a much lower discount rate. While their analysis is based on an estimated departure from marginal cost pricing valid for an optimal long run scale of production, Moschini and Meilke's (1988) results do put some bounds on the implicit discount rate for quota values. Also, they find that the implicit discount rate for quotas seems to adjust fairly rapidly to movements in the interest rate for the general economy, which offers another practical guideline in the process of assuming a discount rate for quota values.

3.2 Caution in using farm-level data

In the preceding sections, we have illustrated the theoretical underpinnings of supply response at the farm level. In estimating a supply response model at the farm level, however, some caution is warranted. If we observed the same farm at different points in time, then the models presented could be estimated with standard econometric procedures. The fact is, however, that the most farm-level data are of the survey type, giving a cross-section of farms at some specific point in time. In general, such cross-sections will not be a suitable data base to estimate supply curves of the type illustrated in Figure 1 and Figure 2.

In a time-series sample, each observation point represents the same economic unit, and thus this set of points can sketch out the adjustments of this unit facing economic conditions varying between time periods. In a cross-section sample, each observation point pertains to a different economic unit, and the differences between sample points illustrates a hypothetical adjustment that would take place if an economic unit were subjected to the economic conditions of another unit. The fact is that the typical set of economic conditions relevant for cross-section adjustments is different from the set of conditions relevant in time-series adjustments. For instance, different levels of production for the same unit between two time periods may represent the response to changed relative prices, while different levels of output between two farms in the same time period, where relative prices are likely to manifest less change, may illustrate a different state in the intertemporal development process, as well as being the result of farm-specific structural characteristics.

This suggests that time-series data will illustrate adjustments along short-run equilibria, while cross-section data will depict adjustments among long-run equilibria, a conjecture that is well established in the literature (Kuh, 1959; Grumfeld, 1961; Baltagi and Griffin, 1984). Thus, models estimated with cross-section nature of the data set utilized by Moschini (1988b) leads to an estimated cost function that is best interpreted as the long-run cost function of the representative farm of the Ontario dairy industry.

3.3 From individual to industry supply response

Even assuming that one could get an accurate estimate of individual supply response at the farm level, additional problems need to be addressed to know how the industry as a whole would react to a price change, which presumably is the policy question of interest. The issues to be addressed in this context are the number and possible diversity of the farms comprising the industry, the possibility of entry and exit into and from the industry (at least in the long run), and the possible endogeneity of some prices at the industry level.

It is well known that a competitive industry with free entry/exit, and all input prices exogenously given, has a perfectly elastic supply curve (Diewert, 1981). An upward sloping supply curve for the industry can be explained by assuming that at least one input has less than perfectly elastic supply (as in Hughes, 1980), or that the industry has inframarginal firms (as in Panzar and Willig, 1978). The inframarginal firm approach has some appeal for analyzing the agricultural sector, as used for instance in Chambers (1980). The difficulty in utilizing this approach for empirical applications is that one needs information about the diversity parameters of the farms, and on the distribution of these parameters at all price levels.

An easier solution is offered by the hypothesis of endogenous input prices for some inputs. An obvious candidate for this kind of input in agricultural production is land. Following Hughes (1980), assume that one input (say the jth input x_j) is not in perfectly elastic supply, that the supply of this input is given by $g(w_j)$, and that there are N firms in the industry. The long run equilibrium of the firm and the industry. The long run equilibrium of the firm and the industry is described by:

(8) $$p - \delta C(y,w) = 0$$

(9) $$N\ x_j(y,w) - g(w_j) = 0$$

(10) $$py - C(y,w) = 0$$

Equation (8) is the individual farm profit maximization condition, (9) equates total demand for the scarce input to supply, and (10) ensures the absence of profit (which is implied by free entry/exit in the long run). Equations (8)-(10) can be solved for the long run equilibrium y^* (the optimal farm output), N^* (the optimal number of farms), and w_j^* (the equilibrium price of the jth input). Now we can define the industry equilibrium supply as:

(11) $$Y^* = N^*\ y^*$$

Thus, the elasticity of equilibrium aggregate supply ϵ_{Y^*p} will satisfy:

(12) $$\epsilon_{Y^*p} = \epsilon_{N^*p} + \epsilon_{y^*p}$$

where $\epsilon_{N^*p} = (\delta N^*/\delta p)(p/N^*)$ is the price elasticity of the equilibrium number of firms, and $\epsilon_{y^*p} = (\delta Y^*/\delta p)(p/y^*)$ is the elasticity of the optimal farm size with respect to price.[6] Differentiating equations (8)-(10) with respect to p and solving yields formulae for $\delta N^*/\delta p$ and $\delta y^*/\delta p$, which can be found in Hughes (1980).

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[6] Carefully note the distinction between y^* and $y(p,w)$ in this setting.

Expressing these results in elasticity form we obtain:

(13) $$\epsilon_{N^*p} = -(1/\Theta)[\eta_{jy}(1-\eta_{jy})] - (1/S_j)(\eta_{jj}-\mu_{jj})$$

(14) $$\epsilon_{y^*p} = (1/\Theta)(1-\eta_{jy})$$

where $\Theta=(\delta^2c/\delta y^2)[y/\delta c/\delta y)]$ is the output elasticity of marginal cost, $\eta_{jy} = (\delta x_j/\delta y)(y/x_j)$ is the output elasticity of the jth input demand, $\eta_{jj}=(\delta x_j/\delta w_j)/(w_j/x_j)$ is the own price elasticity of demand of the jth input, $\mu_{jj}=(\delta g/\delta w_j)(w_j/g)$ is the supply elasticity of the jth input, and $S_j=(w_jx_j)/(py)$ is the share of the jth input cost to total revenue (or total cost, given (10)). Combining (13) and (14) we obtain:

(15) $$\epsilon_{Y^*p} = (1/\Theta)(1-\eta_{jy})^2 - (1/S_j)(\eta_{jj}-\mu_{jj})$$

If we estimate the cost structure of a typical supply managed farm, we can get an estimate of Θ, η_{jy}, η_{jj}, and S_j. Given some prior on μ_{jj}, we can then utilize (15) to determine the industry supply response elasticity in the long run.[7]

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[7] If one has to make an educated guess on all the elasticity parameters in (15), it may be useful to note that, for the single output case, $(1/\Theta)\eta_{yp}$, where $\eta_{yp}=(\delta y/\delta p)(p/y)$ is the supply elasticity of the individual farm when all prices are parametrically given, that is $y=y(p,w)$ or $y=y(p-q,w)$.

4. Aggregate supply response analysis

It is a fact that most studies of agricultural supply response have been conducted directly at the aggregate level. This involves treating an agricultural industry as a single large farm. The conditions that allow this aggregation to be exact can be found in Gorman (1968), and basically require that the shadow value of the constraints (fixed factors or supply managed commodities) be the same for all farms. This will be the case if a market for the fixed factors and the regulated output quotas exists, and farms optimize over these variables. Thus, to satisfy exact aggregation, the microstructure of the aggregate model should be characterized by unconstrained profit maximizing farms, an assumption that may be tenable only for the long run.

Assuming that we can treat an agricultural industry as a single farm, then under some general conditions we can treat the agricultural sector as a single multiproduct farm (Moschini, 1989). The argument is akin to that of section 3.3. If some inputs (such as land) can be used only in the agricultural sector, then their price must be endogenous to the agricultural sector.

To clarify this point, let $\pi^i(p_i,w)$ represent the profit function of the ith industry (i=1,...,I), so that the output supply when all prices are parametrically given is:

$$(16) \qquad y_i(p_i,w) = \delta\pi^i/\delta p_i$$

Let the jth input, x_j, be the one that can be used by the agri-

c u l -

tural sector only, although it may allocated between the various industries of this sector. Given the demands $x_j{}^i(p_i,w) = -\delta\pi^i/\delta w_j$, and an inelastic supply $x_j{}^o$ of this input, the equilibrium price $w_j{}^i(p,w^1)$, where $p=(P_1,\ldots,P_I)$ and $w^1=(w_1,\ldots,w_{j-1},w_{j+1},\ldots,w_j)$, will solve the equilibrium condition:

$$(17) \qquad \Sigma_i\ x_j{}^i(p_i,w) = x_j{}^o$$

Equation (17) introduces a link between agricultural industries, so that the agricultural sector can be represented by the joint profit function $\pi(p,w^1,x_j{}^o)$, yielding a supply function for the industry as:

$$(18) \qquad y_i(p,w^1,x_j{}^o) = \delta\pi/\delta p_i$$

Unlike (16), equation (18) implies that the supply of the ith industry depends also on the price of all other agricultural outputs (which measure, in a sense, the opportunity cost of the fixed resource $x_j{}^o$).

Equation (18) offers the theoretical foundations for specifying a supply function directly at the industry level. For estimation purposes, one would need observations on the output y_i, on the price vectors (p,w^1), and on the fixed resource $x_j{}^o$. These repeated observations are usually provided by time series observations. Specification issues again involve the choice of a functional form, the definition of an expectation process for some components of (p,w^1), and the possible allowance for dynamic adjustments. If one wishes to fully exploit the profit maximization restrictions, the supply functions in (18) should be estimated jointly, possibly together with the aggregate input demand equations as well.

4.1 Aggregate supply response with supply management

The framework developed above can be modified to accommodate the existence of supply management for some commodities. Let y^o be the output subvector of the industries subject to supply management, while (y^1, p^1) represent the subvectors of output supplies and output prices for commodities not affected by supply management. An aggregate restricted profit function can now be written as $\pi(p^1,w^1,y^o,x_j^o)$ (see Moschini, 1988a). The output supply of unconstrained industries is given by:

(19) $$Y^1{}_i(p^1, w^1, y^o, x_j^o) = \delta\pi/\delta p^1{}_i$$

while for the supply managed commodities we can retrieve a shadow price as:

(20) $$p_m{}^o(p^1, w^1, y^o, x_j^o) = - \delta y_m{}^o$$

It can be verified that $p_m{}^o = \delta C/\delta y_m{}^o$, that is the shadow price in (20) is the marginal cost of producing $y_m{}^o$.

This framework of analysis suggests two strategies for empirical applications aimed at estimating the supply function of supply managed commodities. First, if one could obtain a measure of the rental price of quotas q_m, then one could compute $p_m^o = p_m - q_m$, where p_m is the administered price of supply managed commodities. This computed shadow price could be used as the left hand side to estimate the inverse supply response functions (20), possibly jointly with the unconstrained supply equations (19) and the input demand functions. While in principle this allows one to retrieve a measure of the supply elasticity of supply managed commodities, it should be pointed out that the econometric implementation of this strategy may be frustrated by the fact that the supply managed vector y^o typically displays small variability in a time series sample, so that little information is available for the estimation of relevant parameters.

Alternatively, one could estimate $\pi(p^1,w^1,y^o,x_j^o)$ directly, possibly with the aid of the unrestricted supply functions (19) and of the input demand functions. While this does not require any prior information on q, the econometric problems of the previous case are worse. In addition to the lack of variability in y^o, in this case the number of parameters to be estimated is usually large relative to the typical size of time series samples, with immediate degrees of freedom problems.

Both strategies are untested, and may deserve some consideration in future applications. The first of these strategies is perhaps the most promising, as one may obtain reasonable estimates of q from observed quota values or from farm-level cost function estimates. Another possibility worth exploring to reduce the degrees of freedom problem is that of pooling provincial data, while treating the agricultural sector of each province as a single farm. Unfortunately, the use of this type of panel data may create additional problems due to the structural diversity of Canadian provinces, although this is an empirical question.

5. Summary and conclusions

To assess the impact of trade liberalization scenarios being considered in the current round of multilateral trade negotiation, it is imperative to know the potential supply response of Canadian industries that have been for some time under supply management. In this paper we have reviewed the conceptual issues relating to the specification and estimation of supply response models for industries subject to quantity control. The main questions concern the estimation of supply elasticities for these industries, and of the departure from marginal cost pricing (the location of the supply curve).

The paper has outlined alternative research strategies that could be considered for empirical applications. Two broad approaches have been described, one requiring farm-level data, and the other requiring aggregate data. In both cases, one could attempt to estimate supply response and departure from marginal cost pricing directly at the same time (through a cost function approach at the farm level or a restricted profit function approach at the aggregate level). Alternatively, one could rely on a prior measure of the departure from marginal cost pricing in order to estimate supply responsiveness (through a profit function approach). In the latter case, the departure from marginal cost pricing could be obtained by appropriately discounting observed quota values. Given this measure, both farm level data and aggregate data could be used to estimate relevant elasticities of supply regulated industries. If farm level estimates are available, the paper provides some guidelines for inferring industry response from a knowledge of farm response.

PART II: EMPIRICAL APPLICATION

6. Empirical Estimates

While the calculation of the departure from marginal cost pricing is conceptually a straightforward task, as explained above, in practical terms it is very difficult in the Canadian context. This is the case because (1) in almost no situation is there a rental market for quota; (2) in many cases quota is only transferred along with physical assets; and (3) the rules and regulations regarding quota transfer and use differ across provinces and this influences quota values even when marginal cost relationships are identical. Bollman (1988) has estimated the capitalized value of quota for the various supply managed commodities, in most provinces, but in many cases these estimates are based on very thin markets and hence must be considered highly conjectural. This is particularly true in provinces with small production shares.

Unfortunately, only for the case of milk production in Ontario has the careful econometric work been done to estimate the relevant cost structures so that direct comparisons between marginal costs and output prices can be made (Moschini; Moschini and Meilke). Consequently, in the remainder of this section various "second-best" approaches are used in an attempt to answer the question of what supply (shadow) prices would have brought forth the quantity of the various supply managed commodities (milk, chicken, turkey, eggs) actually produced, in absence of supply control (p' - q' in Figure 2) in 1986.

6.1 Milk

Moschini and Meilke using Ontario farm level data from 1978-83 estimate that the departure from marginal cost pricing (distance q' in Figure 2) for industrial milk averaged 15 percent of the industrial milk price. Under the assumption that the marginal cost of producing fluid milk is identical to that for industrial milk the departure from marginal cost pricing in the fluid sector was roughly 30 percent of the fluid milk price.

Using the above estimates of the departure from marginal cost pricing Moschini and Meilke go on to show that the implied discount rate, based on capitalized quota values in Ontario, was closely related to the prime interest rate and over the period 1980/81 to 1985/86 averaged 86.7, 5.9 and 20.7 percent above the prime interest rate for fluid, unused MSQ and used MSQ quotas, respectively. Eliminating the first two years of the observation period, when nominal interest rates were very high, results in significantly lower estimates of the discount rate for unused MSQ and used MSQ of 6.1 percent below and 13.0 percent above the prime interest rate. Consequently, it appears that discount rates vary considerably across similar commodities and also over time (even in relation to the prime rate). However, in order to calculate shadow prices based on capitalized quota values a discount rate must be chosen. For this analysis discount rates 10 and 85 percent above the prime rate are chosen for industrial and fluid milk, respectively. These numbers are roughly consistent with the findings of

Moschini and Meilke and imply discount rates of 11.6 and 19.4 percent for industrial and fluid milk quotas in 1986 when the prime rate averaged 10.5 percent.

Table A.1 contains data on milk production by province, average fluid and industrial milk prices (including the direct federal subsidy), the average blend price (weighted average of fluid plus industrial) as well as Bollman's estimates of capitalized quota values. In Table A.2 two methods have been used to calculate shadow prices.

Table A.1: Milk Production, Average Fluid and Industrial Milk Prices and Estimated Quota Values by Province, 1986

Province	Milk Production[a/] (kilolitres)		Net Cash Receipts ($/hl)[a/]			Estimated Quota Value[b/]
	Fluid	Industrial	Fluid	Industrial	Average	$/hl
PEI	13,903	79,042	45.12	35.20	36.68	27.00
NS	116,012	59,469	53.00	34.65	46.78	80.00
NB	70,286	57,556	50.19	36.34	43.95	50.50
QUE	685,953	2,153,993	48.67	37.57	40.25	64.20
ONT	995,988	1,346,494	52.03	37.98	43.95	76.20
MAN	114,028	147,843	49.53	37.03	42.47	65.70
SASK	97,484	110,503	52.71	37.84	44.81	56.50
ALB	257,950	309,522	48.09	36.74	41.90	47.30
BC	311,680	176,182	51.91	45.38	49.55	116.70
NEWF	17,026	0	64.62	--	64.62	NA
CANADA	2,680,310	4,440,604	50.73	37.83	42.69	69.7

a/ Includes the value of direct subsidies and net of marketing costs. Based on data provided by Susie Miller and M. Côtè, Ag. Canada.

b/ Estimates provided by Bollman (1988).

In Method 1 the shadow price in each province is assumed to be 85 percent of the industrial milk price, i.e. a departure from marginal cost pricing of 15 percent of the industrial milk price. Since the figure of 15 percent was taken from Ontario this implicitly assumes that for every dollar by which a province's industrial milk price deviates from that in Ontario, 85 cents represents a difference in marginal costs relative to Ontario and 15 cents in annual returns to quota values.

Using this criteria shadow prices vary from a low of $29.45/hl in Nova Scotia to a high of $38.57/hl in British Columbia. However, the shadow price in most provinces lie between $30.50 and $32.50/hl. The estimated shadow prices can be used to calculate the implied discount rate, using formula 21 and Bollman's provincial quota value estimates.

$$\text{(21) Capitalized Value of Quota} = \frac{\text{(Average Price - Shadow Price)}}{\text{Discount Rate}}$$

These implied discount rates vary from a low of 9.4 percent in British Columbia to a high of 25.9 percent in New Brunswick.

The second method of calculating the shadow prices relies on the now assumed constant discount rates for quota of 11.6 (industrial) and 19.4 (fluid). The first column of Table A.2, under method 2, calculates the relevant discount rate for each province based on the share of fluid and industrial milk in total milk production. These discount rates are then used in conjunction with formula (21) to provide estimates of the provincial shadow prices.

Table A.2: Estimated Shadow Prices for Milk Production in Canada, by Province, 1986

Province	METHOD 1 Average Price[a/] ($/hl)	Shadow Price[b/] ($/hl)	($/cow)[f/]	Discount Rate[c/]	METHOD 2 Implied Discount Rate[d/]	Estimated Shadow Price[e/] ($/hl)	($/cow)[f/]
PEI	36.68	29.92	1406	25.0	12.8	33.22	1561
NS	46.78	29.45	1619	21.7	16.8	33.34	1834
NB	43.95	30.89	1606	25.9	15.9	35.92	1868
QUE	40.25	31.93	1565	13.0	13.5	31.58	1548
ONT	43.95	32.28	1646	15.3	14.9	32.60	1662
MAN	42.47	31.47	1479	16.7	15.0	32.62	1533
SASK	44.81	32.16	1576	22.4	15.3	36.17	1772
ALB	41.90	31.23	1624	22.6	15.1	34.76	1807
BC	49.55	38.57	2623	9.4	16.6	30.18	2053
NEWF	64.62	NA	NA	NA	19.6	NA	NA
CANADA	42.69	32.15	1639	15.1	14.5	32.50	1662

a/ Blend price of industrial and fluid milk from Table 1.
b/ Calculated as 85 percent of the industrial milk price. Based on results of Moschini and Meilke for Ontario.
c/ Calculated as (Average Price - Shadow Price)/Quota Value (from Table 1).
d/ Weighted average of assumed fluid milk discount rate of .194 and industrial milk discount rate of .116.
e/ Calculated as shadow price = Average Price - (estimated discount rate x capitalized quota value).
f/ Based on Bollman's estimates of milk production per cow.

In comparing the results from methods 1 and 2 the shadow price estimates are quite close for Ontario, Quebec and Manitoba which accounted for 76.4 of Canadian milk production in 1986. For the remaining Provinces there is little a priori evidence favoring one set of estimates over the other and perhaps commodity analysts judgement should be relied upon in choosing the "best" number.

6.2 Broilers

Table A.3 contains estimates of the shadow price (calculated using the formula developed by Fox et al.) and market price of Ontario broiler chicken for 1982-86. The difference between the market price and shadow price gives the implied quota rental value or annual departure from marginal cost pricing. Table A.3 reveals that this rental value declined substantially in 1985, from 1984 and turned negative in 1986. This resulted from a sharp increase in U.S. chicken prices relative to those in Ontario in 1986 largely as the result of (a) reduced supply caused by very hot summer weather; (b) strong domestic demand; (c) a 30 percent increase in exports; and (d) capacity constraints that limited supply response. More normal price relationships returned by the last half of 1987. Since the 1986 price increase in the U.S. was at least partly the result of exogenous shocks, and not due to underlying marginal cost relationships, data for this single year likely gives a distorted picture of Canadian shadow prices.

The last four columns of Table A.3 show the estimated capitalized quota values, at various discount rates, for the years 1982 to 1985 based on the estimated quota rental values.

Table A.3: Estimated Broiler Chicken Quota Values Based on Canada-United States Price Relationship

Year	Estimated Shadow Price[a/] (C$/MT evisc.)	Market Price[b/] (C$/MT evisc.)	Implied Quota Rental Value (C$/MT evisc.)	Implied Quota Rental Value (C$/bird liveweight)[c/]	Prime Interest Rate	Capitalized Value of Quota (C$/bird) at Prime Rate	15%	20%	25%
1982	1197	1480	283	0.55	15.8	3.48	3.67	2.75	2.20
1983	1219	1493	274	0.54	11.2	4.82	3.60	2.70	2.16
1984	1302	1630	328	0.64	12.1	5.29	4.27	3.20	2.56
1985	1341	1493	152	0.30	10.6	2.83	2.00	1.50	1.20
1986	1550	1507	-43	-	10.5	-	-	-	-
1982-84	1239	1534	295	0.58	13.0	4.46	3.86	2.90	2.32
1984-86	1377	1543	146	0.29	11.1	2.61	1.93	1.45	1.16

a/ Calculated and updated according to the formula Canadian Price = 4.093 + 1.032 x U.S. Price (in C$). Liveweight price is converted into an eviscerated price using a coefficient of 1.37. U.S. price from Fox et al., p. 153-54.

b/ Average price received by Ontario Farmers, Ag. Stats for Ontario, 1987, p. 9. Converted to eviscerated weight by multiplying by 1.37.

c/ Calculated as C$/MT (evisc.) / (1000 x 1.43 (ave. kg/bird) x 1.37 (to convert to liveweight)).

Bollman estimates the 1986 capitalized value of Ontario broiler quota at $3.58 per bird. Using 1984/86 average data this would imply a discount rate of 8.1 percent and using 1982/84 data a discount rate of 16.2 percent. While generalizing is difficult a discount rate of 15 percent would not appear unreasonable in light of the data in Table A.3.

Table A.4 contains 1986 data on broiler prices by province and variable costs taken from the Canadian Chicken Marketing Agency cost of production formula. The difference between these two figures gives a very rough approximation of the margin above average variable costs.[8] Note that only at the minimum of the average variable cost curve will this measure correspond to the margin above marginal costs. This value (poultry price-variable cost) is then taken as a rough measure of the departure from marginal cost pricing and an implied discount rate calculated based on Bollman's estimates of capitalized quota values. In all cases, except one, the discount rate estimates are greater than 15 percent and average 20 percent for Canada. Using the broiler data presented above two methods can be used to calculate shadow prices for broilers (Table A.5). In method 1 a constant discount rate of 15 percent is assumed and shadow prices are calculated using

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8 Only feed, chick and energy costs were included. This assumes that for firms purchasing quota the opportunity cost of capital and labor is zero. It also assumes that feed, chick and energy costs have been measured accurately.

Bollman's quota values. In method 2 the departure from marginal cost pricing is assumed to be measured accurately by subtracting the variable cost estimates in Table A.4 from the market price.

Not surprisingly, method 2 generally results in lower estimates of the relevant shadow price than method 1. In choosing between the two sets of figures the relevant criteria is whether the discount rate is equal to 15 percent (method 1) or greater than 15 percent (method 2). And for method 2 whether the variable cost estimates are good guides to marginal costs. For the provinces of Quebec, Ontario and British Columbia (which accounted for 77percent of 1986 broiler production) the two estimates are within ten percent of each other.

The method 1 estimates suggest that the shadow price for Ontario broiler production was 25 percent below the market price, in 1986, and for Canada, 21 percent below the Canadian average price.

6.3 <u>Eggs</u>

The procedure used to calculate the shadow price of Canadian eggs is identical to that used for chicken. Table A.6 shows annual estimates of the shadow price for Ontario eggs based on the procedure used by Fox <u>et al.</u> The implied rental value of egg quota is 36.4 cents per dozen for the period 1984-86. Bollman's estimated quota value per bird in 1986 was $35 in Ontario and $29.60 based on a national average (Table A.7). These figures suggest a discount rate of around 25 percent for egg quota.

Table A.4: Estimated Provincial Discount Rates for Broiler Chicken Quota, 1986

Province	Chicken Production[a/] ('000 eviscerated kg.)	%	Ave. Monthly Price Live Poultry[b/] (c/kg)	(c/bird)	Variable Costs[c/] (c/kg)	Average Weight[d/] kg/bird (live)	Poultry Price-Var. Costs c/kg	c/bird	Quota Value[e/] $/bird	Implied Discount Rate[g/] %
PEI	705	0.1	NA	NA	96.9	1.88	NA	NA	NA	NA
NS	16,858	3.6	114.7	215.6	90.7	1.88	24.0	45.1	1.49	30.3
NB	13,232	2.8	NA	NA	89.6	1.88	NA	NA	1.23	NA
QUEBEC	149,463	31.7	107.8	224.2	83.0	2.08	24.8	51.6	2.86	18.0
ONT	164,849	34.9	109.4	212.2	75.6	1.94	33.8	65.5	3.58	18.3
MAN	19,278	4.1	106.8	194.4	80.5	1.82	26.3	47.9	1.64	29.2
SASK	12,313	2.6	NA	NA	85.4	1.82	NA	NA	1.04	NA
ALB	39,591	8.4	111.4	198.3	81.3[f/]	1.78	30.1	53.6	2.06	26.0
BC	49,225	10.4	111.9	222.7	81.4	1.99	30.5	60.7	4.22	14.4
NEWF	6,334	1.3	NA	NA	110.4	1.88	NA	NA	1.16	NA
CANADA	471,847	100.0	109.4	214.4	79.1	1.96	30.3	59.4	2.97	20.0

a/ Canadian Chicken Marketing Agency.
b/ Poultry Market Review 1986, p. 10, Average price for broiler chicken, under 2.3 kg, live to producer (Vancouver, Edmonton, Regina, Winnipeg, Toronto, Montreal, Halifax).
c/ Touche Ross, Cost of Production Update, Broilers. Calculated as sum of feed cost + chick cost + energy cost.
d/ Estimates of average eviscerated weight taken from CRAM model and converted to liveweight by multiplying by 1.37.
e/ Bollman estimates.
f/ Estimated by Meilke.
g/ Discount rate = (Poultry Price - Var. Costs)/Quota Value

Table A.5: Estimated Shadow Prices for Broiler Production in Canada, by Province, 1986

Province	Method 1[a/] ($/kg)	Method 1[a/] ($/bird)	Method 2[b/] ($/kg)	Method 2[b/] ($/bird)
PEI	NA	NA		NA
NS	1.03	1.93	0.91	1.70
NB	NA	NA	NA	NA
QUE	0.87	1.81	0.83	1.73
ONT	0.82	1.59	0.76	1.47
MAN	0.93	1.70	0.81	1.46
SASK	NA	NA	NA	NA
ALB	0.94	1.68	0.81	1.45
BC	0.81	1.62	0.81	1.59
NEWF	NA	NA	NA	NA
CANADA	0.87	1.70	0.79	1.55

a/ Calculated as Poultry price - 0.15 x Quota value from Table 4.
b/ Equal to variable cost estimate from Table 4.

In Table A.7 provincial egg prices and variable cost estimates are compared and again a discount rate in excess of 25 percent is suggested. In fact, in some provinces the implied discount rates are extraordinarily large suggesting that either the variable cost estimates, or the quota values, are understated.

Table A.8 shows estimated shadow prices using a constant discount rate of 25 percent of Bollman's quota value estimates (method 1), and method 2 where the variable cost estimates in Table 7 are assumed to be an accurate representation of marginal costs. Estimates using the two methods are within ten percent of each other for three provinces (Ontario, Quebec, British Columbia) representing 67.7 percent of 1986 total egg production, and for the Canada average. There are, however, wide departures in the shadow price estimates for some provinces, depending on whether method 1 or method 2 is used.

The calculations for method 1 suggest that Ontario shadow prices for eggs are 40 percent below market prices and 34 percent below market prices based on national averages. Method 2 estimates are even lower.

6.4 Turkey

Turkeys are the final commodity examined using the methodology developed for chicken and eggs. Table A.9 contains estimated shadow prices for Ontario turkeys based on pre-supply management price relationships between Ontario and the United States. Bollman estimated Ontario turkey quota to be worth $11.99/bird in 1986. This would suggest a discount rate between 20 and 25 percent in 1986, or on a 1984/86 average. Data on a provincial level (Table A.10) comparing variable cost estimates and Bollman's quota value estimates imply discount rates far in excess of 30 percent for all provinces except Ontario. Hence a 25 percent discount rate would

Table A.6: Estimated Egg Quota Values Based on Canada-United States Price Relationships

Year	U.S. Price[a/] ($US/MT)	e.r.[b/] ($US/$C)	Estimated Shadow Price[c/] (C$/MT)	Canadian Price[d/] (C$/MT)	Implied Quota Rental Value (C$/MT)	Implied Quota Rental Value (C$/doz)	Prime Interest Rate	Capitalized Value of Quota (C$/layer) Prime Rate	15.0%	20.0%	25%
1982	833.3	0.809	911.6	1378	466.4	32.6	15.8	47.8	50.3	37.8	30.2
1983	916.6	0.811	1000.2	1408	407.8	28.5	11.2	58.9	44.1	32.9	26.4
1984	952.8	0.772	1092.3	1520	427.7	29.9	12.1	57.3	46.2	34.8	27.8
1985	715.3	0.731	866.0	1467	601.0	42.0	10.6	91.9	65.0	48.7	39.0
1986	769.7	0.719	947.4	1479	531.6	37.2	10.5	82.1	57.5	43.2	34.6
1984-86	812.6	0.741	968.6	1489	520.1	36.4	11.1	76.1	56.1	42.2	33.8

a/ U.S.D.A., Livestock and Poultry Situation, farm price of table eggs. Converted from $/doz. to $/kg by multiplying by 1.43. These figures correct an error in Fox *et al.*, p. 157.

b/ Taken from FARMBANK.

c/ Calculated as 0.885 times U.S. price in Canadian dollars following the procedure of Fox *et al.*

d/ OECD estimates as taken from TASS model worksheets.

e/ Assumed rate of lay 23.2 doz./yr. - 1986 CRAM model figure.

Table A.7: Estimated Provincial Discount Rates for Egg Quota, 1986

Province	Egg Production[a/] ('000 doz)	%	Egg Price[b/] (c/doz)	Egg Price[b/] ($/bird)	Variable Cost[c/] (c/doz)	Yield[d/] (doz./bird)	Egg Price-Variable Cost (c/doz.)	Egg Price-Variable Cost ($/bird)	Quota Value[e/] $/bird	Implied Discount Rate[f/] %
PEI	3,153	0.7	98.0	22.1	59.9	22.6	38.1	8.61	5	172.2
NS	17,831	3.8	96.6	21.8	60.8	22.6	35.8	8.09	15	53.9
NB	10,237	2.2	95.3	21.5	59.3	22.6	36.0	8.14	10	81.4
QUEBEC	78,209	16.5	93.2	21.5	56.6	23.1	36.6	8.45	30	28.2
ONT	182,639	38.7	90.9	21.7	51.0	23.9	39.9	9.54	35	27.2
MAN	53,402	11.3	85.0	19.9	49.3	23.4	35.7	8.34	25	33.4
SASK	18,801	4.0	89.7	18.8	51.6	20.9	38.1	7.96	15	53.1
ALB	40,619	8.6	91.2	19.6	49.8	21.5	41.4	8.90	20	44.5
BC	59,051	12.5	94.2	22.2	52.1	23.6	42.1	9.93	40	24.8
NEWF	8,320	1.7	103.1	23.3	70.3	22.6	32.8	7.41	10	74.1
CANADA	472,262	100.0	91.6	21.2	54.0	23.2	37.6	8.72	29.6	29.5

a/ Census of Agriculture, 1986 as provided by Michael Katz.
b/ Poultry Market Review, 1986, weighted average prices to producers for all grades.
c/ Based on Agriconsultants pricing formula, sum of feed cost plus pullet cost.
d/ Estimates taken from CRAM model. These estimates are roughly 11 percent higher than indicated by Census data.
e/ Bollman estimates.
f/ Calculated as Discount Rate = (Egg price - Var. costs)/quota value.

Table A.8: Estimated Shadow Prices for Egg Production in Canada, by Province, 1986

Province	Method 1[a/]		Method 2[b/]	
	($/doz)	($/layer)	($/doz)	($/layer)
PEI	0.92	20.90	0.60	13.54
NS	0.80	18.08	0.61	13.74
NB	0.84	19.04	0.59	13.40
QUE	0.61	14.03	0.57	13.08
ONT	0.54	12.98	0.51	12.19
MAN	0.58	13.64	0.49	10.35
SASK	0.72	15.00	0.52	10.79
ALB	0.68	14.61	0.50	10.71
BC	0.52	12.23	0.52	12.30
NEWF	0.92	20.80	0.70	15.89
CANADA	0.60	13.85	0.54	12.53

a/ Calculated as Egg market price - 0.25 x Quota value from Table A.7.
b/ Equal to variable cost estimate from Table A.7.

appear to be a conservative estimate of the discount rate for turkey quota.

Shadow prices calculated using methods 1 and 2 are reported in Table A.11. Method 1 results in shadow prices considerably higher than method 2 for all provinces except Ontario. It seems most likely that the variable costs used in method 2 have underestimated the true marginal cost.

Table A.9: **Estimated Turkey Quota Values Based on Canada-United States Price Relationship**

Year	Estimated Shadow Price[a] (Cc/kg live)	Actual Price[b] (Cc/kg live)	Implied Quota Rental Value (C$/kg)	Implied Quota Rental Value (C$/bird)	Prime Interest Rate	Prime Rate	Capitalized Value of Quota (C$/layer) 15%	20%	25%	30%
1982	94.5	143.9	0.49	3.94	15.8	24.9	26.3	19.7	15.8	13.1
1983	87.1	135.6	0.49	3.94	11.2	35.2	26.3	19.7	15.8	13.1
1984	112.0	149.8	0.38	3.06	12.1	25.3	20.4	15.3	12.2	10.2
1985	115.4	143.7	0.28	2.25	10.6	21.2	15.0	11.2	9.0	7.5
1986	106.6	142.0	0.35	2.82	10.5	26.9	19.0	14.2	11.4	9.4
1984-86	111.3	145.2	0.34	2.73	11.1	24.6	18.2	13.6	10.9	9.1

a/ Based on results of regressing Toronto heavy hen turkey prices (5.4 - 9 kg) on the U.S. farm price of turkeys 1965-73. Ontario price (c/kg) = -2.80 + 1.117 x U.S. price (cc/kg).

b/ Average price for turkey, live to producer, (5.4 - 9 kg), Toronto. Taken from FARMBANK variable AIAP036M.

c/ Converted from $/kg to $/bird by multiplying by 8.05 kg/bird.

The shadow prices calculated according to method 1 suggest that the supply price for Ontario turkey was 26 percent and for Canada 17 percent below the market price for young heavy hen turkeys.

6.5 Summary and Conclusions

In the preceding analysis an attempt has been made to estimate the shadow prices of Canadian milk, chicken, egg and turkey products. The authors would be the first to admit that they are based on a weak scientific basis. However, given the limited time in which to conduct the analysis, the lack of reliable data and the need for provincial estimates, perhaps it is the best that can be done. It is likely that the shadow prices presented in this report are lower bounds for the true value. Consequently, sensitivity analysis using higher values should form an important part of any policy analysis.

The analysis suggests that the marginal supply prices (shadow price) for industrial milk were 10-15 percent below industrial milk prices while for chicken, turkeys and eggs they were 20, 17 and 34 percent below market prices. Personal communication with an industry specialist has provided estimates of marginal supply

Table A.10: Estimated Provincial Discount Rates for Turkey Quota, 1986

Province	Turkey Production ('000 evisc. kg)[a/]	%	Ave. Price Live to Producer[b/] (c//kg)	Ave. Price Live to Producer[b/] ($/bird)	Variable Cost[c/] (c//kg)	Yield kg/ bird (live)[d/]	Average Price-Variable Cost c//kg	Average Price-Variable Cost $/bird	Quota Value[e/] ($/bird)	Implied Discount Rate
PEI	NA	NA	NA	NA	NA	5.0	NA	NA	NA	NA
NS	2,109	2.0	152.8	7.64	106.6[f/]	5.0	46.2	2.31	2.52	91.7
NB	1,307	1.3	NA	NA	106.1[f/]	5.0	NA	NA	2.50	NA
QUEBEC	24,253	23.5	140.0	9.16	96.6	6.54	43.4	2.84	6.54	43.4
ONT	44,756	43.4	142.2	11.45	95.3	8.05	46.9	3.77	11.99	31.4
MAN	8,044	7.8	144.0	12.18	96.1	8.38	47.9	4.01	6.68	60.0
SASK	3,994	3.9	152.3	12.87	101.2	8.45	51.1	4.32	1.69	255.6
ALB	8,442	8.2	153.2	12.39	95.0	8.09	58.2	4.71	6.23	75.6
BC	10,113	9.8	152.0	11.86	102.0	7.80	50.0	3.90	7.30	53.4
NEWF	NA	NA	NA	NA	NA	5.0	NA	NA	NA	NA
CANADA	103,018	100.0	144.3	10.98	98.1	7.61	46.2	3.65	8.64	42.2

a/ Canadian Turkey Marketing Agency, annual report 1987.

b/ Poultry Market Review 1986, p. 12. Average prices for young heavy hen turkey at selected markets (Vancouver, Edmonton, Regina, Winnipeg, Toronto, Montreal, Halifax), live to producer, 5.4-9.0 kg.

c/ Canadian Turkey Marketing Agency, cost of production for hen turkeys, sum of feed and poults cost, average of March 3, June 2, Sept. 5, Dec. 5, 1986.

d/ Estimate taken from CRAM model and converted to liveweight by multiplying by 1.22.

e/ Bollman estimate.

f/ Broiler prices.

Table A.11: Estimated Shadow Prices for Turkey Production, by Province, 1986

Province	Method 1[a/] ($/kg)	Method 1[a/] ($/bird)	Method 2[b/] ($/kg)	Method 2[b/] ($/bird)
PEI	NA	NA	NA	NA
NS	1.40	7.01	1.07	5.33
NB	NA	NA	NA	NA
QUE	1.15	7.52	0.97	6.32
ONT	1.05	8.45	0.95	7.68
MAN	1.20	10.09	0.97	8.17
SASK	1.27	10.75	1.01	8.55
ALB	1.28	10.36	0.95	7.68
BC	1.27	9.91	1.02	7.96
NEWF	NA	NA	NA	NA
CANADA	1.19	9.08	0.96	7.33

a/ Calculated as Turkey market price - 0.25 x Quota value from Table A.10.

b/ Equal to variable cost estimate from Table A.10.

prices for Canadian poultry (chicken + turkey) of 10 percent below the market price and 20 percent below for eggs.

7. Supply Elasticities

In order to evaluate the impacts of trade liberalization on Canada's supply managed sector, the CRAM model requires both an estimate of the departure from marginal cost pricing (as discussed above) and an estimate of the relevant supply elasticities for these commodities.

Under supply management it is not possible to directly estimate the aggregate supply curve (marginal cost curve) from observed domestic price/quota constrained quantity choices. Consequently, in the absence of other information estimates of the supply elasticities for Canadian milk, chicken, eggs and turkeys have to be based on information available from other markets. Given the geographic proximity of the U.S. market and the general availability of elasticity estimates for this market, it seems logical to survey the literature for supply elasticity estimates for the United States.

7.1 Milk

The choice of an appropriate supply elasticity for milk is complicated by the long production process, which implies that the supply elasticity varies greatly depending on the amount of time allowed for producers to adjust to price changes. In the short-run (one year or less) there is general consensus that milk supply is very price inelastic, with an estimate of 0.1 being quite

Table A.12: Summary of Milk Supply Elasticity Estimates

Source	Time Period	Region	Length of Run Short-run	Long-run
Cromarty	1929-53 annual	United States	0.21	2.53
Halvorson	1927-58 1944-57 annual	United States	0.003	0.52
Wipf and Houck	1954-64 annual	United States	0.03-0.14	0.04-0.19
Chen, Courtney and Schmitz	1953-68 quarterly	California	0.16 (4 qtrs.)	2.53 (7 years)
Prato	1950-68 annual	United States	0.006	0.007
Hammond	1947-72 annual	United States, nine regions	0.09	0.15
Elterich and Masud	1966-78 quarterly	Delaware	0.92 (4 qtrs.)	2.82 (11 qtrs.)
Milligan	1958-73 semi-annual	California	0.43-0.52	0.92-1.08
Dahlgran	1954-83 annual	United States	0.12	1.00 (6 years) 2.00 (16 years)
Burton		United States	0.04	0.51 (4 years)
Thraen and Hammond	1949-78 annual	United States	NA	1.15
Chavas and Klemme	1960-82 annual	United States	0.11	0.89 (5 years) 2.46 (10 years) 6.69 (LR)
LaFrance and de Gorter	1950-80 annual	United States	0.30-0.50	4.8-8.0
Kaiser, Streeter and Liu	1949-85 annual	United States	NA	0.80 (5 years)
Howard and Shumway	1951-82 annual	United States	-0.08-0.05	0.14-0.23

This table was taken in part from Buxton and Dahlgran.

representative (Table A.12). In the longer run, milk supply becomes considerably more elastic as enough time is allowed for additional cows to be added to the dairy herd. Studies of the United States market conducted prior to the mid-1970s, using simple price expectations mechanisms, generated vastly different supply elasticities ranging from Prato's near zero estimate to estimates in excess of 2.0 by Cromarty; Chen, Courtney and Schmitz; and Elterich and Masud.

More recent studies using complex expectations and dynamic adjustment mechanisms appear to provide more precise estimates of the time path of milk supply response. Allowing six years for producers to adjust to price changes Chavas and Klemme found a supply elasticity of 0.89 while over the same adjustment period Dahlgran found it to be 1.0. Kaiser, Streeter and Liu's five year milk supply elasticity is 0.80. Elasticities calculated allowing even more time for adjustment result in even larger supply elasticities ranging up to an estimate of 8.0 in LaFrance and de Gorter. The work of Howard and Shumway is the only recent study to find an inelastic long-run milk supply response.

The AAEA Task Force on Dairy Marketing Orders in attempting to summarize their survey of milk supply elasticities came to the conclusion that ..."a quite high long-run supply elasticity, say more than 2, makes a good deal of economic sense given modern dairy production methods (p. 51)".

Since the CRAM model is a long-run model a milk supply elasticity allowing five years for adjustment to price changes would seem reasonable. Consequently, a direct supply elasticity in the range of 0.8 to 1.0 would appear to be supported by the available literature. A cross-price elasticity with respect to feed prices might be in the range of 0.2-0.4 although here the empirical evidence is weaker.

7.2 Poultry and Eggs

Numerous studies of the poultry and egg industries appear in the literature (see bibliography) but very few of them report the supply elasticities of interest. The most comprehensive study, containing the needed information, was conducted by Chavas (1978). He found the long-run supply elasticities for broilers, turkeys and eggs to be 0.8, 1.7 and 0.9, respectively. Soliman's long-run elasticity for turkeys 1.1 supports the conclusion that turkey supply response is elastic. Thus, elasticities near 1.0 for broilers and eggs and perhaps slightly higher for turkeys would appear to be consistent with the limited empirical work addressed to this question. Others, however, may argue that these supply elasticities likely understate the "true" long-run supply elasticity given the lack of specialized resources used in producing poultry products. Cross price elasticities with respect to feed costs in the poultry industry might be in the range of 0.5 to 0.7.

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