Working Papers Series

WORKING PAPER WP95/06 July 1995

OPTIMAL INVESTMENT IN GENERIC ADVERTISING AND RESEARCH: THE CASE OF THE CANADIAN SUPPLY MANAGED EGG MARKET UNDER PARTIAL TRADE LIBERALIZATION

by

Ellen W. Goddard

UNIVERSITY of GUELPH

Department of Agricultural Economics and Business

University of Guelph
Guelph, Ontario
Canada
N1G 2W1

OPTIMAL INVESTMENT IN GENERIC ADVERTISING AND RESEARCH: THE CASE OF THE CANADIAN SUPPLY MANAGED EGG MARKET UNDER PARTIAL TRADE LIBERALIZATION

by

Ellen W. Goddard*

WORKING PAPER WP95/06
Department of Agricultural Economics and Business
University of Guelph
Guelph, Ontario

July 1995

* Associate Professor, Department of Agricultural Economics and Business, University of Guelph.

Acknowledgements

The author acknowledges the research assistance of Daphne Taylor as well as Karen Chyc whose earlier work on the model provided the basic data base for this analysis.

The author would also like to acknowledge the Ontario Milk Marketing Board, the Ontario Pork Producers Marketing Board, the Ontario Egg Producers Marketing Board, the Dairy Farmers of Canada and the Ontario Ministry of Agriculture, Food and Rural Affairs for providing financial support for this project.

OPTIMAL INVESTMENT IN GENERIC ADVERTISING AND RESEARCH: THE CASE OF THE CANADIAN SUPPLY MANAGED EGG MARKET UNDER PARTIAL TRADE LIBERALIZATION

E.W. Goddard
Dept. of Agricultural Economics and Business, University of Guelph

INTRODUCTION

The Canadian Egg Marketing Agency (CEMA) was established in 1972. It was the first federal marketing agency designed to operate a national supply management system for an agricultural product. The agency allocates production quota to each provincial marketing board, which then allocates its quota among producers based on previous production levels. Under supply management, it is not possible for a producer to enter the industry or expand operations without purchasing an existing operation with quota; even then, this quota would not be moveable (Green). Another feature of the supply managed egg market is the restriction of imports (binding import quotas) which, combined with a fixed supply, help establish a target market or intervention price for eggs. The level of the target market price is established based on average costs of production in the industry. Since the amount of production quota is set on a per hen basis rather than on the basis of number of eggs produced, the supply of eggs available in the market can exceed consumer demand. CEMA purchases any unsold eggs produced within quota at the target market price, and subsequently disposes of them in the breaker egg market (Green) at a lower unregulated breaker egg price. The costs of this diversion are covered by producer levies which are included in the setting of the target market price for table eggs.

Recent trade liberalization initiatives have changed the regulations through which supply management operates. Binding import quotas are no longer allowed under the General Agreement on Tariffs and Trade. Instead supply managed industries will operate with a system of international minimum access agreements and tariffs. In 1995 minimum access to the egg market is 3% of domestic consumption during the base period 1986-1989 (rising to 5% by the end of six years). For eggs being imported under minimum access agreements the tariffs are a minimal 3.5¢/dozen. Over access commitment eggs will be imported at a 192.3% (at least

94¢/dozen) tariff (table eggs) or 280.4% tariff (hatching eggs). Over the six years of the agreement tariffs are to be reduced by 15%.

Egg producers through their provincial and federal marketing agencies also engage in activities which assist in the goal of profit maximization. Two such activities are advertising and research and development (R&D). Since 1975, CEMA has been involved in generic advertising of eggs. In 1993, it spent $4,020,000 on advertising and promotional activities while the Ontario Egg Producer's Marketing Board (OEMB) spent an additional $1,500,000 in this area, (CEMA Annual Report, OEMB Annual Report). The advertising activities of each agency over time are presented in Figure 1. While other provincial egg marketing boards can also engage in independent advertising activities no other provinces have chosen to significantly supplement the national advertising campaign by running their own. Generic advertising activities in the Canadian egg market are represented by CEMA and OEMB activities. All advertising costs are covered by producer levies which are included in the setting of the target market price for table eggs.

One reason to conduct R&D is to develop new technologies which lower the costs of the production process. Successful research and development of this sort shifts the supply curve out to the right. The majority of cost reducing R&D in the Canadian egg industry has been conducted by the federal government, with some additional expenditure at the provincial government levels. In the past, this research has mainly been concerned with husbandry and management practices for laying hens which has been incorporated into the technology of egg production (see Figure 2). More recent research includes the areas of nutrition, physiology and biotechnology which will hopefully have practical applications in the future (OEMB Annual Report). The federal government spends in the neighbourhood of $2.5 million annually on laying hen research (Haque et al., Fox et al.). Both CEMA and OEMB have historically invested very little in R&D. In 1993, CEMA spent $166,000 on research, most of which was for market research, while OEMB spent $112,000 on research grants for more applied R&D work. The OEMB has also sponsored a chair in egg research at the University of Guelph. Incomplete data is available on recent provincial government investment in R&D for the egg sector.

Like all investments, advertising and R&D should only be carried out by the firm/industry to the point where each is profitable (Perrakis). The purpose of this paper is to develop and apply optimal advertising and R&D investment rules for the Canadian Egg Marketing Agency. These optimal investment levels will be significantly affected by the trade liberalization that is occurring in the industry. To satisfy this objective it will be necessary to quantify the link between advertising and sales and to quantify the link between research and marginal costs in the egg industry. An econometric model of the Canadian egg market within the context of North American egg trade will be specified, estimated and validated. The model will provide the basis for a static optimization of investment in advertising and R&D. Optimal and actual investment levels will be compared.

MODEL SPECIFICATION

The Canadian egg market can be represented graphically by Figure 3. The cost of production is established and supply is set where the producer price will just cover the average cost of production (a price higher than the marginal cost price from the supply curve). The difference between the producer price and the marginal cost price reflects what producers would be willing to pay for production quota for a single period's production, if quotas were freely auctioned or negotiated.

The costs of production are determined on three basic components - actual costs, the administrative levy and the diversion levy. From these three components the Grade A price of eggs in the market is determined. This can be linked directly to the average producer price of eggs. The determination of the producer price leads to the formation of the retail market price for eggs which determines the retail level consumption of fresh eggs. Given that, and the allowance of a fixed level of imports, the table egg supply or production level is determined and table eggs can be diverted to the breaker or export market as necessary. Breaker egg prices are determined largely in the U.S. market and can be considered exogenous[+]. With an increased volume of trade under trade liberalization

---

[+] This model excludes the introduction of the separate breaker egg supply management system introduced in 1988/89.

(and ignoring for the moment the tariffs since they are initially set too high to allow trade beyond minimum access) the egg industry has a number of options. The increased quantity (SMQ' - SMQ) could be diverted to the breaker market. The additional diversion costs associated with this make it unlikely. The board could allow the CoP producer price (PP) to fall to PP' where the same volume of eggs would be diverted to the breaker market as before trade liberalization. An alternate solution would be to reduce production quotas by the amount of the increased imports so that SMQ' would equal SMQ. Over time as tariff levels decline the egg industry will lose the ability to determine price completely.

Supply of eggs (reflecting the production quotas imposed by the marketing agency) is essentially an exogenous variable in the Canadian egg market. Table eggs, once produced, can freely move from the fresh to the breaker market increasing or decreasing diversion costs as they go. As the marginal costs of egg production move in response to research so total costs (the integral of the marginal cost curve) and average costs (total costs/supply) can be determined from the marginal costs and can directly respond to changes in the level of research expenditure. This reduction in average production costs can be reflected by a reduction in the actual cost component of the Grade A producer price (cost of production). As consumption of table eggs increases in response to advertising, fewer eggs will be diverted to the breaker market and cost of production price will adjust to higher administrative levies and lower diversion levies. With supply of table eggs held constant producer surplus as measured as the area under producer price (adjusted for administrative and diversion levies) and above marginal cost (supply) curve will not change with additional advertising expenditure but will increase with investment in research. For every effective dollar spent on advertising, diversion costs decrease and administrative costs increase. The optimal advertising investment would balance this tradeoff. Advertising would not increase to the point where diversion costs are zero since marginal costs would exceed marginal benefit at that point. With this structure of the Canadian egg industry additional producer surplus can only be generated from advertising if production quota expands.

The regulations operating in the Canadian egg market make the economic problem associated with optimizing investment in research or advertising different than the case of an unrestricted monopolist (Chyc and Goddard, Dorfman and Steiner). It becomes necessary to derive optimizing criteria for the case of a regulated monopolist with fixed production and variable sales to two markets. Prices for the monopolist can only move in response to changes in the components of the cost of production price; average costs, administrative levies or diversion levies. The price relevant for the determination of producer surplus is the average cost price. The profit maximization problem for the producer egg board could be expressed as:

$$\text{Max } \pi = (PP - ADMIN - DIV) * SEGG - C(SEGG,R)$$

For optimal advertising $$\frac{\partial \pi}{\partial A} = SEGG\left(\frac{\partial PP}{\partial A} - \frac{\partial ADMIN}{\partial A} - \frac{\partial DIV}{\partial A}\right) = 0$$

For optimal research $$\frac{\partial \pi}{\partial R} = SEGG\left(\frac{\partial PP}{\partial R} - \frac{\partial ADMIN}{\partial R} - \frac{\partial DIV}{\partial R}\right) - \frac{\partial C}{\partial R} = 0$$

where PP = cost of production price

ADMIN = administrative levy = $\frac{A + R}{SEGG}$

DIV = diversion levy = $\frac{(PP - BEP)\,SBG}{SEGG}$

A = advertising investment

R = research investment

BEP = breaker egg price

SBG = table egg sales to breaker market

SEGG = fixed supply of table eggs.

The above optimizing procedure can be applied within an econometric model specified for the egg sector.

The question of whether it is appropriate or not to characterize the egg industry as a monopolist arises with the advent of trade liberalization. For at least the first six years of the new trade agreement much control of the domestic egg industry is still left in the industry's hands due to the high level of proposed tariffs and only

gradual erosion of those tariffs. It is clear that control is not quite as rigid as in the past since the volume of imports is higher.

The optimal investment conditions developed are applied in a static risk neutral framework. It is recognized (Aykac et al.) that uncertainty may play a large role in affecting optimal advertising expenditure levels. For example, regression coefficients, as sample estimates of population parameters are themselves a source of uncertainty. The optimality conditions above are predicated on implied risk neutrality of decision makers. Risk averse decision makers may sacrifice some expected profit to reduce profit variance resulting in a different optimal investment level. The degree of risk aversion of investment decision makers in the egg industry will not be considered. It is possible that divergence between actual and estimated optimal level of investment in advertising may provide an indirect assessment of risk aversion on the part of egg industry decision makers.

Econometric Model

Given trade liberalization and the possibility of increased linkages with the North American egg industry in the future it becomes necessary to model both Canada and U.S. egg markets simultaneously.

A model of the North American table egg market for Canada contains:

1. a behavioural retail level per capita demand equation for table eggs (including advertising)
2. a behavioural supply (marginal cost) equation for table eggs (including research investment)
3. a behavioural price linkage equation for retail to producer price linkage
4. a behavioural producer price linkage equation to the cost of production price
5. an identity ensuring that supply and demand for eggs are equal given net trade and diversion to the breaker market
6. an identity quantifying the static quota value by the difference between producer price and marginal cost
7. an identity quantifying costs of production.

For the U.S. an egg model contains:

1. a behavioural retail level per capita demand equation

2. a behavioural breaker demand equation

3. a behavioural supply equation for eggs

4. a behavioural price linkage equation for retail to farm prices

5. an identity relating consumption to production given net trade between Canada and the U.S. and the Rest of the World and net changes in stocks.

All equations are specified in annual form. Details about other aspects of Canadian equation specification can be obtained from McCutcheon and Goddard and Chyc and Goddard. The most critical equations for determining optimal investment behaviour are the Canadian retail demand equation and the farm supply equation. Further details about these equations are provided below.

A. Demand for Eggs

Consumer theory suggests that consumption of a particular commodity is related to prices and income. Advertising effects, if any, arise through changes in marginal utility associated with advertised and non-advertised products.

However, demand can conceivably be estimated as price, quantity or expenditure dependent. With more than one explanatory variable resulting elasticities/flexibilities are not invariant to the selection of dependent variable. The demand specifications selected for this study are:

> Retail per capita expenditure as a function of per capita consumption of table eggs, income, advertising expenditure, time
>
> Retail per capita expenditure, as a function of retail price, income, advertising expenditure and time.

Advertising, price, income and expenditure are all expressed in logarithmic form in the equations. A lagged dependent variable is included to represent habit persistence. Homogeneity is imposed in the equations by deflating prices, and income by the consumer price index. Advertising is also deflated by the consumer price index since a media cost index was not available. A time trend is included to account for structural change in

demand arising possibly from health concerns. Advertising expenditure is defined as the sum of the logs of CEMA advertising, CEMA promotion and OEMB advertising.

The U.S. demand equation is estimated as a simple per capita consumption equation with retail price, income and time as explanatory variables. Quantity data are expressed on a per capita basis. Price variables are deflated by the U.S. Consumer Price Index to maintain homogeneity. Advertising expenditure data were not available for the U.S. Habit persistence is incorporated through a lagged dependent variable. U.S. breaker egg demand is modelled as an input demand equation. The relevant price is the farm price for processors purchasing eggs for inputs in their manufacturing process.

B. Supply of Eggs

The Canadian supply equation for eggs is problematic due to supply management in the industry. Observable producer prices and supplies are not related to the supply curve but to the demand curve. The marginal cost price, or the price that is related to the supply curve can be derived from the producer egg price by subtracting static quota values. This assumes quotas are freely negotiable over the entire sample period. Discount rates must be assumed to derive static quota values from the observed quota values which represent values in perpetuity. The supply equation can be represented as:

$$\text{Supply of Eggs} = f(\text{Marginal Cost, Price of Feed, Research Expenditure}_{(t-D)}, \text{Supply of Eggs}_{t-1})$$

Marginal cost prices and feed prices will be deflated to ensure homogeneity. Following previous research (Chyc and Goddard) the supply equation will be specified in logarithmic form. Research expenditure lags are specified and tested based on previous supply response models established by Haque et al. The model is specified to be twice differentiable with respect to research. The exclusion of provincial and U.S. research expenditures may bias the estimated parameters in the model. However, it was not found possible to update the series used in Haque et al.

The U.S. supply equation is specified in a similar manner with the exclusion of the research variable. Since modelling the impact of research investment was not an issue in the U.S. market the equation is estimated in linear form. Farm egg prices and corn prices are used as explanatory variables.

DATA

Data on Canadian table egg disappearance, production, breaker egg diversion, net trade in eggs, and prices were obtained from the Agriculture Canada Farm databank and Statistics Canada (see below) annually for the period 1974-1993. The retail price of eggs was in index form and therefore a conversion was made to dollars by multiplying by $1.26 (a base period 1981 average price of eggs). Data on disappearance was converted to per capita basis by dividing by population and all monetary variables were deflated by the consumer price index in order to impose homogeneity for both demand and supply equations. Eggs produced for the breaker market were not included in the model. Similar data for the U.S. was collected from USDA publications.

A list of all data used and the acronyms used throughout the analysis and the rest of this paper is provided in Appendix 1.

ESTIMATED RESULTS

Estimation of empirical equations was done using Ordinary Least Squares Regression in TSP Version 4.1. Table 1 presents the Canadian expenditure dependent logarithmic demand equation results. Other specifications (without a time varying parameter on quantity for example) were tested and rejected if they suggested backward bending demand curves. Advertising expenditure variables were lagged zero, one and two periods and the coefficient presented was selected on the basis of the largest t-statistic. The calculated elasticities are of theoretically correct signs and remarkably different magnitudes. The demand elasticities estimated are compared to those of previous studies in Table 2. The elasticities reported in this study for equation one are smaller than those reported in McCutcheon and Goddard but similar to those reported in Chyc and Goddard. The equation with price as an explanatory variable produces a much more inelastic demand curve.

Further examination of the 'inelastic' demand curve revealed it to be unsuitable for simulation purposes. In fact the inclusion of time and habit persistence make the equation unstable and it becomes backward bending in response to price over the sample period (tested by simulating the equation). With the sample period 1974-1992 neither linear nor logarithmic specifications of price dependent or quantity dependent equations produced statistically significant or, in some cases, correctly signed own price effects. Although there is some doubt about the magnitude of the demand elasticity and the simulation results are significantly dependent on the magnitude of that particular elasticity further simulations were done with only the more elastic demand curve.

The U.S. per capita consumption equation is also presented in Table 1. Again coefficients are of plausible signs and magnitudes. Income is not statistically significant in any of the three reported equations. The demand elasticity reported is much smaller in the U.S. than in Canada.

The U.S. egg market model includes a breaker egg demand equation. Breaker egg demand is modelled as function of U.S. farm prices of eggs. A lagged dependent variable is also included in the equation. There is a strong upward trend in breaker egg disappearance in North America possibly impacting on the size of the coefficient on the lagged dependent variable. The breaker equation is presented in Table 3.

The results from the estimated supply equations are presented in Table 3. Both Canadian and U.S. supply equations were estimated as quantity dependent. As suggested previously, the Canadian equation was estimated in logarithmic form. The Canadian supply elasticities estimated in this study are compared to those from other studies in Table 4. The results generated in this study are very similar to those generated in the earlier studies (Haque et al., Chyc and Goddard).

The results from the two Canadian price linkage equations are presented in Table 5. The two equations suggest a strong and direct passage from the cost of production price to producer price and on to the retail price for shell eggs. Given the regulated nature of the market these results are not too surprising. The U.S. farm retail price linkage equation is also presented in Table 5. The U.S. equation also suggests a strong direct passage from retail price to farm price.

MODEL SIMULATION

The estimated equations were combined with the necessary identities to close the model and were simulated over the historical period 1985-1992. The base model assumes that Canadian supply is an exogenous policy-determined variable and solves for per capita consumption of table eggs and diversion to the breaker market, retail price, producer price, quota value, and the marginal cost price of eggs. U.S. endogenous variables include production, consumption, breaker egg disappearance, retail and farm prices. Trade between Canada and the U.S. is an exogenous policy determined variable and trade with the rest of the world is exogenous. The COP, administrative levy and diversion costs are basically exogenous in the base run although some error will be generated in the diversion of eggs due to the stochastic nature of the demand for table eggs. The validation statistics are provided in Table 6 for the model with the first Canadian retail level demand equation.

For the Canadian side of the model there is very little give in a regulated market model where supply is exogenous and cost of production (determined largely on the basis of exogenous factors) determines prices through the marketing chain. The bulk of the error in the model is picked up by the only truly endogenous variable, static quota values. In spite of the error in that variable, the model was deemed to be satisfactory for the purposes of examining what would have happened if advertising and research expenditure levels had been different over the period 1985-1992.

SCENARIOS

The first issue that is of concern to egg producers is what would have happened if the Canadian egg market had faced the GATT 'minimum access' imports over the period 1985-1992 rather than actual imports. This analysis can be conducted under two scenarios, either that producers allow the regulated producer price to fall to absorb the additional imports (maintaining historical diversion and production levels) or that production is reduced by the amount of increased imports (maintaining historical pricing and diversion levels). The base models are used to illustrate these two scenarios.

Actual and hypothesized increased import levels are presented in Table 7. The scenario is what would have happened if the GATT agreement had been signed in 1985. The increased imports are all assumed to have originated from the U.S. Thus, the U.S. market would also have been affected by the trade liberalization. Results of this simulation are presented in Table 8.

The results suggest that increased trade over the period 1985-1992 would have resulted in higher U.S. farm prices and lower consumption. In Canada producer surplus would have been lower under either scenario. Production would have to fall by approximately one percent if prices are to remain relatively unchanged (except through levies to cover administrative and diversion costs). If prices were allowed to fall and production remained constant, consumption rises and average producer price falls by approximately two percent.

The other scenarios that are of particular interest concern the optimal allocation of advertising and research investment for the Canadian Egg Marketing Agency (on behalf of Canadian egg producers) within the context of increased trade under the two possible egg industry reactions.

The decision rules (as presented in a previous section) results from the maximization of producer surplus. Producer surplus is the producer revenue (PP (adjusted by the administrative and diversion levies) x SEGG) minus the area under the supply curve minus fixed costs. In the base run of the various models, CEMA's contribution to basic research is set at zero. The research expenditure used in the estimation of the supply equation is that of the federal government (an underestimate of the total research and extension component by exclusion of provincial government contributions and spill-in from U.S. research programs). This contribution by the federal government is maintained at its actual level throughout the following analysis and CEMA (or producers) make up the difference between optimal investment in research and the federal budget. Similarly CEMA's investment in promotion and the OEMB's investment in advertising are held fixed at their actual levels throughout all further analysis.

In the estimated supply and demand equations (see Tables 1, 3) advertising and research impact on demand and supply respectively with a lag (one year in the case of advertising, six years in the case of research). While not disregarding the importance of the length of time before a market response is evidenced, it was decided

to simplify the analysis by assuming the lagged responses away. In other words supply and demand are each assumed to respond instantaneously to an infusion of money into advertising or research programs. The simulation results are to be presented at the mean over the seven year simulations so they may be interpreted as a snapshot picture of how a market responds to advertising or research. There is no question that including the time lag before a result is felt in the market would generate a somewhat higher return to investment in advertising when compared to research than the following results would suggest. Thus, the following results are biased by assuming away the lags in response.

Using the estimated equations from Tables 1, 3 and 5 and the framework from Section 1 optimal behavioural rules for investment in advertising and research can be derived and are presented in Table 9.

Results for each of the simulations for each market condition are provided in Table 10.

When advertising is the only choice variable for the Canadian Egg Marketing Agency optimal advertising expenditure levels are higher than actual. The infusion of additional advertising dollars raises the administrative levy but at the same time encourages the sales of more eggs on the table market. Diversion costs and the diversion levy are accordingly lowered. The marginal cost price for eggs is unchanged but quota values are slightly increased. In the case where production quotas are reduced in response to increased trade, optimal advertising expenditure increases producer surplus to levels very similar to those achieved without trade liberalization. Prices rise with the increased advertising. Supply of eggs is also higher with advertising but lower than that produced before trade was liberalized. The scenario where production falls but CoP remains the same produces higher producer surplus.

When research is the only choice variable for the Canadian Egg Marketing Agency optimal research expenditure levels are much higher than actual. CEMA (or producers) contribute the additional research dollars thus increasing the administrative levy considerably. The reduction in marginal (average and total) costs that occurs from investment in research results in lowered producer prices, retail prices and costs of production and moves a lot of eggs from the breaker market to the table market. Diversion costs are lowered as are the diversion levies. Quota values for the market increase. Producer surplus over all eggs sold increases. Optimal investment

in research would allow production to rise to levels higher than without trade liberalization and allow for increased producer surplus. Per capita consumption would increase in response to lower prices. The scenario where production falls rather than price falling generates higher producer surplus.

CONCLUSIONS

The results presented illustrate two possible reactions to partial trade liberalization in the Canadian egg market. The industry faces the possibility of allowing egg prices to fall as increased imports are absorbed or allowing production to shrink to maintain price as increased imports are absorbed. Simulation results suggest that if the above partial trade liberalization had occurred over the period 1985-1992 producers would have been better off adopting a strategy of reducing production rather than allowing price to drop. However this is a short term response that would become more untenable as tariffs fall. The real information lies in the amount of producer surplus lost as price falls with increased imports, a 2.7% decline at the mean over the sample period.

As well, results have been provided on optimal investment in advertising and research for the Canadian egg market. The results suggest that both activities have the potential to improve market opportunities for Canadian egg producers. More importantly, in the context of partial trade liberalization, the results highlight the critical importance of examining the returns to a variety of activities the industry may be able to engage in. The results suggest that the egg industry may wish to examine the possibility of investing in basic research to forestall market realities with increased trade. However, clearly advertising investments will remain important to the industry to stem off downward pressure on producer surplus.

It is also critical that uncertainty about estimated response rates be incorporated into the determination of optimal investment levels. Dynamic optimization techniques would provide a more realistic basis for determining optimal investment. It is also worth remembering that investments in research take a long time to produce payoffs. The results presented oversimplify market responses to research investments.

As always with any econometric analysis the Lucas critique applies. It is relevant to talk about unreliability of estimated parameters for policy analysis when the policy implications include dramatic changes

in the level of certain variables. The problem certainly applies to the current research. The results are more meaningful in highlighting the direction of changes in advertising and research investment than they are in specifying the exact optimal level of investment in advertising and research.

It is worthwhile for the industry to know that investments in advertising are generating positive payoffs for producers. Future market realities make investment in advertising and promotion an even more critical investment for egg producers. Egg producers should also consider longer term investments in basic research.

FIGURE 1

Egg Advertising and Promotion Expenditures

Canada and Ontario

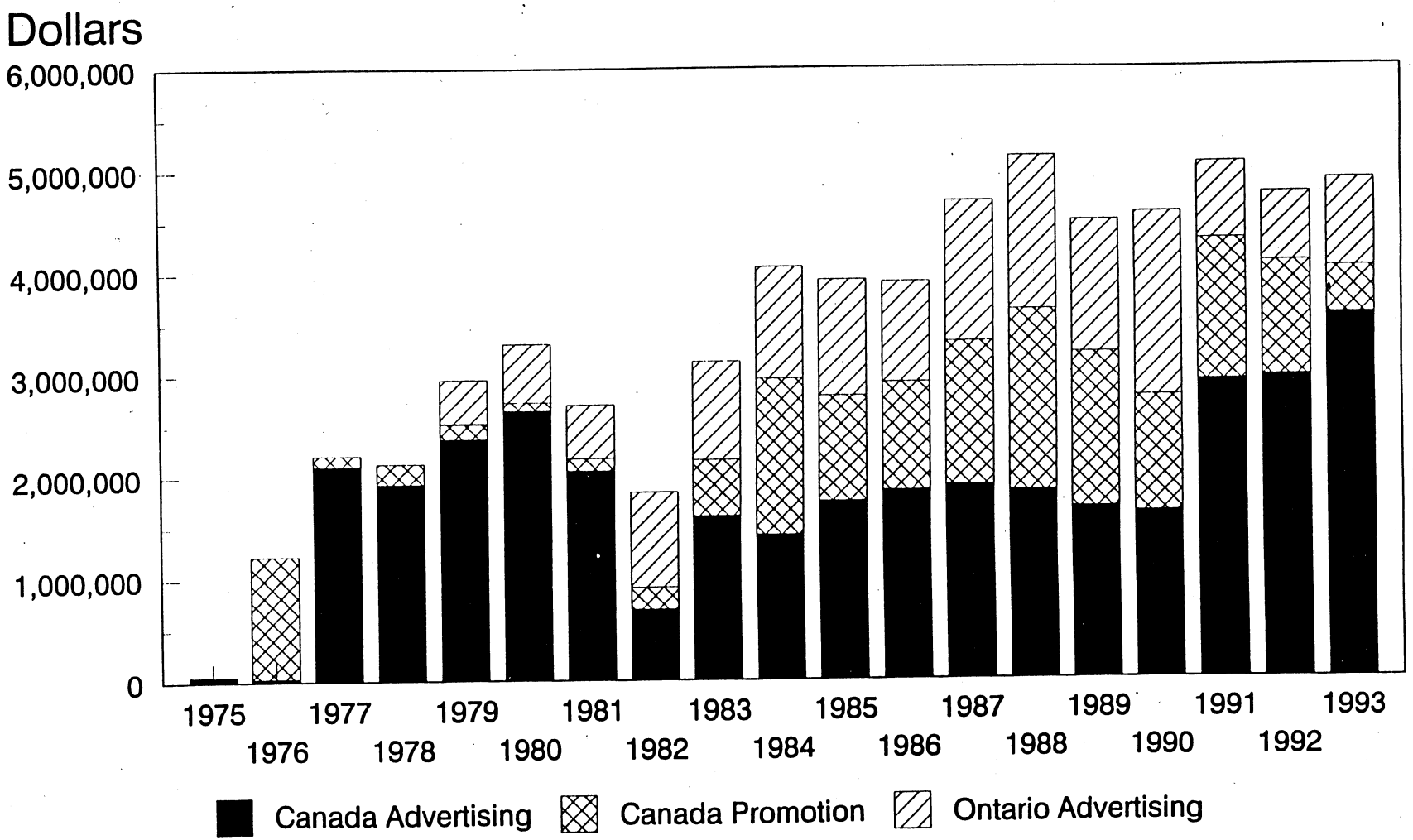

Figure 2: Federal Laying Hen Research Expenditures

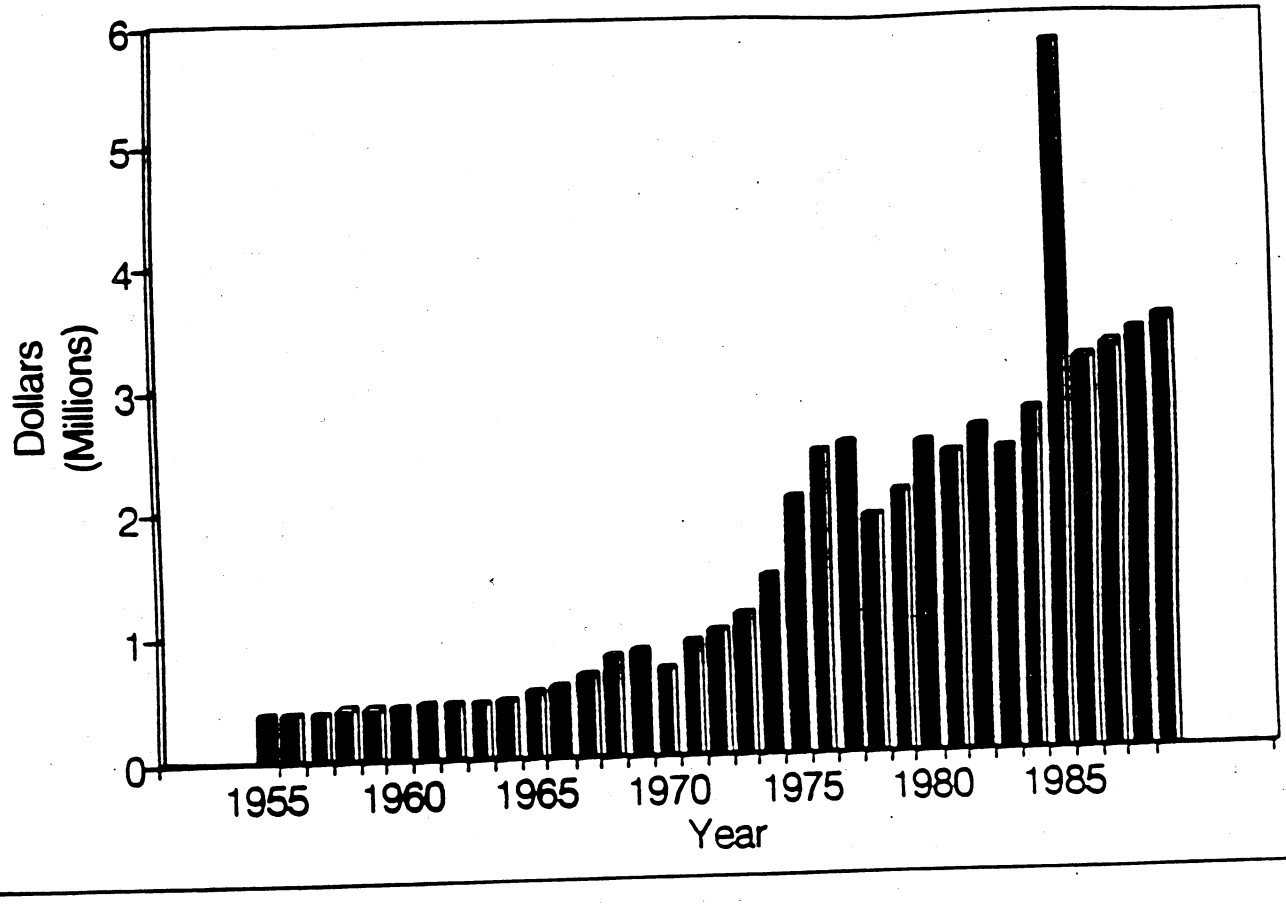

Figure 3: Canadian Egg Market

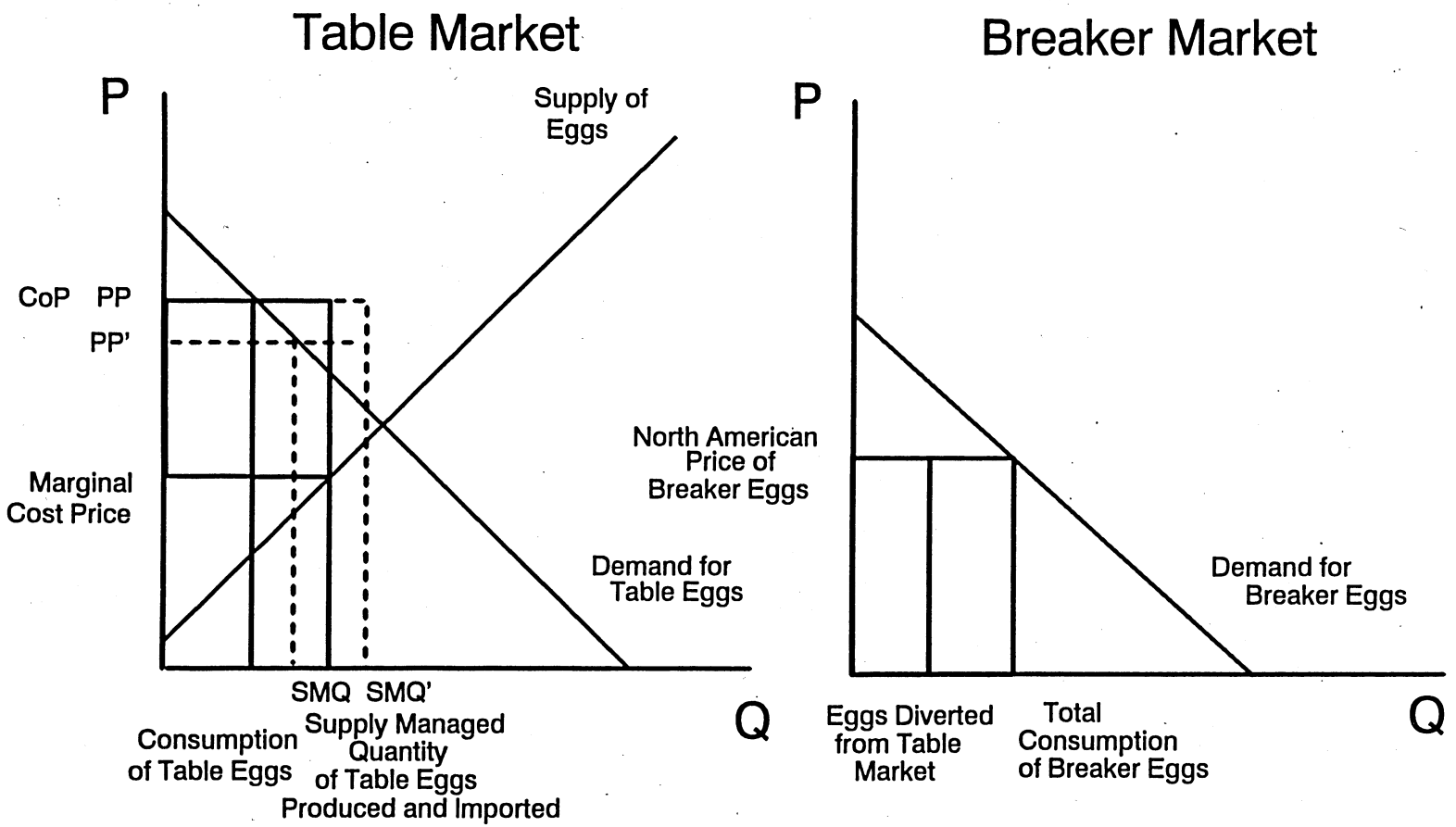

Table 1: Table Egg Demand

Variable*	Coefficient	t-Statistic	Flexibilities
CANADA Dependent Variable: log of expenditure on eggs 1974-1992			
Constant (D0)[2]	1.354	.168	
PCEGGxTIME (D1)	-0.0087	-3.29	-1.1566
PCDI (D2)	0.0277	.0801	.0277
ADV[1]xTIME(-1) (D3)	0.00052	2.64	.009
EEXP(-1) (D4)	0.46435	2.69	
R^2 = .98 F-Statistic = 145.72 Durbin h alternative = -.95			
CANADA Dependent Variable: log of expenditure on eggs 1974-1992			Elasticities
Constant (DA0)	-.3885	-.073	
RP (DA1)	.7589	4.55	-.241
PCD1 (DA2)	.0774	.337	.077
ADV (-1)(DA3)	.0033	3.29	.003
TIME (DA4)	-.0013	-.174	
EEXP (-1) (DA5)	.4850	3.96	
R^2 = .99 F-Statistic = 264.722 Durbin h alternative = -.114			
UNITED STATES (linear) Dependent variable: per capita disappearance of eggs 1971-1992			Elasticities
Constant	8.076	1.58	
USRP	-.029	-2.15	.045
UPCDI	.0002	.331	.033
TIME	-.130	-2.06	
UPCC(-1)	.701	4.21	
R^2 = .97 F-Statistic = 153.339 Durbin h alternative = .432			

[1] ADV = log(AD1) + log(PR1) + log(AD2)

[2] coefficient names are for later use in optimization formulae

* All Canadian variables are in natural logarithms, logged variable is multiplied by time for the time varying parameter.

Table 2: Comparison of Canadian Demand Elasticities

	Price	Income	Advertising	Period
This Study				
Equation 1	-.864	.027	.009	(a) 1974-1992
Equation 2	-.215	.034	.008	(a) 1974-1992
Chyc and Goddard				
Equation 1*	-.856	.439	.007	(a) 1974-1989
Equation 2*	-.849	.293	(ad1).012 (pr1).00005 (ad2).008	(a) 1974-1989
Equation 3*	-.895	.723	.004	(a) 1974-1989
McCutcheon & Goddard				
- Expenditure Equation*	-1.12 -2.16	-.86 -.90	.05 .09	(q) 1978-1989 (q) 1978-1987
Curtin et al.	-0.07	-0.35		(a) 1960-1985
Van Kooten	-0.614	-3.109		(a) 1960-1984
Hassan and Johnson	-0.121	0.000		(a) 1950-1972
Andrikopoulos et al.	-0.545	0.417		(a) 1958-1981

* Calculated by inverting the estimated demand equations.

(q) refers to quarterly
(a) refers to annual

Table 3: Egg Supply Equation

Dependent Variable: Supply of Eggs 1975-1992

Variable*	Coefficient	t-Statistic	Elasticities
CANADA			
Constant (S0)	5.354	16.426	
FPCO2 (S1)	-0.0262	-.87	-.026
RES(-6) (S2)	0.1088	2.60	.109
MCPxTIME (S3)	0.2449	2.26	.245
RHO (S4)	0.8678	8.18	

R^2 = .90
F-Statistic = 2094.81

* All variables expressed in natural logarithms

Variable	Coefficient	t-Statistic	Elasticities
U.S.			
Constant	1576.03	1.69	
USFP(-1)	13.572	2.55	.054
FPCO4	-9.924	-3.91	-.067
USPROD(-1)	.7344	4.68	

R^2 = .75
F-Statistic = 18.47
Durbin h-alternative = .221

Dependent Variable: U.S. Breaker Demand

Variable	Coefficient	t-Statistic	Elasticities
Constant	143.607	(1.08)	
USFP	-3.478	(-1.52)	.099
USBREAK(-1)	.9541	(8.30)	

R^2 = .93
F-Statistic = 151.178
Durbin h-alternative = .747

Table 4: Comparison of Supply Elasticities

This Study	Marginal Cost/Price	R&D	Period
This Study			
EQUATION 1 - Logarithmic			
Short Run	0.24	0.11	1975-1992
Chyc and Goddard			
EQUATION 1 - Logarithmic			
Short Run	0.27	0.14	(a) 1975-1989
Long Run	0.44	0.23	(a) 1975-1989
EQUATION 2 - Linear			
Short Run	0.26	.15	(a) 1975-1989
Long Run	0.41	.24	(a) 1975-1989
Haque et al.			
Linear	0.272	0.256	(a) 1968-1984
Partial Logarithmic	0.264	0.244	(a) 1968-1984

Table 5: Price Linkage Equations

Dependent Variable: Canadian Retail Price of Eggs 1974-1992

Variable	Coefficient	t-Statistic	Price Transmission Elasticity
Constant (K0)	0.0535	2.526	
PP (K1)	0.9960	12.966	.71
RP(-1) (K2)	0.2301	4.111	
R^2 = .99			
F-Statistic = 1428.33			
Durbin h-alternative = 1.80			

Dependent Variable: Canadian Average Producer Price of Eggs

Variable	Coefficient	t-Statistic	Price Transmission Elasticity
Constant	0.0228	2.72	
COP	0.9138	92.06	.97
R^2 = .99			
F-Statistic = 8474.57			
Durbin h-alternative = 1.20			

Dependent Variable: U.S. Producer Price of Eggs

Variable	Coefficient	t-Statistic	Price Transmission Elasticity
Constant	-2.780	-1.54	
USRP	.5652	6.91	.852
USFP(-1)	.2591	2.35	
R^2 = .91			
F-Statistic = 108.57			
Durbin h-alternative = 1.073			

Table 6: Validation Statistics: North American Egg Model

Variable	Mean	Correlation Coefficient	RMSE	RMSPE
CANADA				
Marginal Cost	.59	.77	.079	13.4
Retail Price	.99	.98	.023	2.3
Producer Price	.70	.99	.019	2.7
Static Quota Value	.11	.28	.058	52.7
Per Capita Consumption	13.88	.93	.40	2.9
U.S.				
Per Capita Consumption	20.61	.96	.24	1.16
Retail Price	26.24	.41	7.09	27.02
Breaker Eggs Sold	927.14	.98	69.15	7.5
Production	5728.33	.29	104.35	1.8

Table 7: Actual and Shocked Egg Import Levels

	Actual Disappearance	Hypothesized Minimum Access		Actual Egg Imports
	million dozen	million dozen		million dozen
1986	363.32251	3%	10.8997	8.09162
1987	359.18262	3.5%	12.5714	6.39264
1988	353.22314	4.0%	14.1289	4.40182
1989	347.29712	4.5%	15.6284	7.69911
1990	346.40308	5.0%	17.3202	10.91902
1991	346.00024	5.5%	19.0300	14.49670
1992	350.89844	6.0%	21.0539	14.08407

Table 8: Simulation Results From Increased Trade at the Mean
Over the Simulation Period 1985-1992

	Base	IF Production Falls	IF CoP Falls
Retail Price ($/doz.)	.950	.946	.931
Producer Price ($/doz.)	.674	.670	.658
CoP ($/doz.)	.713	.708	.695
Administrative Costs ($/doz.)	.013	.013	.013
Diversion Costs ($/doz.)	.060	.059	.057
Static Quota Value ($/doz.)	.162	.179	.145
Producer Surplus ($ million)	217.101	214.985	211.238
Supply (million doz.)	408.240	404.199	408.240
Breaker Egg Diversion (million doz.)	64.944	64.944	64.944
Per Capita Consumption (doz.)	13.490	13.549	13.702
U.S. Per Capita Consumption (doz.)	20.445	20.437	20.437
U.S. Farm Price (¢/doz.)	13.945	14.031	14.031

Table 9: Optimal Behavioural Rules for CEMA's Investment in Advertising and Research

ADVERTISING

(1) $$AD1 = \frac{D3 * TIME}{R1} * RP * \left(\frac{SEGG}{K1} - SBG3 \right)$$ Equation 1

RESEARCH

(2) $$RSRCH = \left(\frac{S2}{S3 + 1} \right) * PQ * SEGG$$

Table 10: Impact of Optimal Advertising and Research Expenditure in a Trade Liberalized Market, 1985-1992

If Production Falls

	BASE Production Falls	Optimal Advertising	Optimal Research
Retail Price ($/doz.)	.946	.958	.911
Producer Price ($/doz.)	.670	.680	.642
CoP ($/doz.)	.708	.719	.678
Administrative Costs ($/doz.)	.013	.020	.033
Diversion Costs ($/doz.)	.059	.061	.054
Static Quota Value ($/doz.)	.179	.177	.377
Producer Surplus ($ million)	214.985	216.347	220.280
Supply (million doz.)	404.199	406.794	414.201
Breaker Egg Diversion (mil. doz.)	64.944	64.944	64.944
Per Capita Consumption (doz.)	13.549	13.647	13.931
U.S. Per Capita Consumption (doz.)	20.437	20.437	20.437
U.S. Farm Price (¢/doz.)	14.031	14.031	14.031
AD1 (Total) ($ million)	1.379	4.4153	1.379
AD1 ($/person)	.05265	.16889	.05265
RSRCH	2.4422	2.4422	10.87965
PRSRCH	0	0	8.43745

If Prices Fall

	BASE CoP Price Falls	Optimal Advertising	Optimal Research
Retail Price ($/doz.)	.931	.953	.931
Producer Price ($/doz.)	.658	.676	.658
CoP ($/doz.)	.695	.715	.695
Administrative Costs ($/doz.)	.013	.020	.032
Diversion Costs ($/doz.)	.057	.060	.057
Static Quota Value ($/doz.)	.145	.164	.406
Producer Surplus ($ million)	198.524	201.934	212.296
Supply (million doz.)	408.240	408.240	408.240
Breaker Egg Diversion (mil. doz.)	64.944	64.944	64.944
Per Capita Consumption (doz.)	13.702	13.702	13.707
U.S. Per Capita Consumption (doz.)	20.437	20.437	20.437
U.S. Farm Price (¢/doz.)	14.031	14.031	14.031
AD1 (Total) ($ million)	1.3786	4.4094	1.3786
AD1 ($/person)	.05265	.16866	.05265
RSRCH	2.4422	2.4422	2.4422
PRSRCH	0	0	7.8919

Appendix 1

RP	-	retail price of eggs, ¢/dozen = Consumer Price Index for eggs * 1.26, Statistics Canada.
PP	-	producer price of eggs, ¢/dozen = weighted average price to producers, all grades, FARM databank, Agriculture Canada.
MCP	-	marginal cost price of eggs, ¢/dozen = (PP - SQV)
SQV	-	static quota value, ¢/dozen = Quota values[+] * Bank of Canada prime interest rate
TIME	-	time trend (accounts for technological or structural change)
PCEGG	-	per capita egg consumption = (SEGG - net trade - SBG)/population
SEGG	-	supply, million dozen = production of shell eggs, Canada, FARM databank, Agric. Canada
SBG	-	diversion breaker eggs, million dozen, Canada, FARM databank, Agric. Canada
EXP	-	expenditure on eggs, ¢/dozen = (RP * PCEGG)
PCDI	-	per capita income (income/population) = personal disposable income, Statistics Canada
FPCO2	-	farm price corn, $/tonne - FARM databank, Agric. Canada.
AD1	-	annual advertising expenditure by the Canadian Egg Marketing Agency
PR1	-	annual promotional expenditure by the Canadian Egg Marketing Agency
AD2	-	annual advertising expenditure by the Ontario Egg Producer's Marketing board, dollars per person, annual reports and personal communication
RES	-	investment in laying hen research by the government of Canada $'000, Source - Haque, Fox and Brinkman updated
COP	-	cost of production determined price of Grade A eggs, ¢/dozen, FARM databank, Agric. Canada
ADMIN	-	administrative levy, calculated by percentage figures from CEMA annual reports multiplied by the COP, ¢/dozen
DIV	-	diversion levy, calculated by percentage figures from CEMA annual reports multiplied by the COP, ¢/dozen

[++] Quota values were obtained in part from Economic Intervention and Regulation in Canadian Agriculture (1977-1982), and in part from the Ontario Egg Producers' Marketing Board (1982-1992). Weighted average quota values per hen were converted to a per dozen basis by dividing by an average production level of 22 dozen eggs per hen.

U.S. Variables

USRP	-	retail price of eggs, ¢/doz., region average Grade A large, USDA, Livestock and Poultry Situation
USFP	-	farm price of eggs, ¢/doz., USDA, Livestock and Poultry Situation
UPCC	-	U.S. per capita consumption eggs, doz./person, total egg consumption/population
USPROD	-	U.S. production eggs, million doz., USDA, Livestock and Poultry Situation
FPC04	-	farm price corn, $ tonne, USDA, Livestock and Poultry Situation
USBREAK	-	U.S. breaker egg use, million doz., USDA, Livestock and Poultry Situation
USPOP	-	U.S. population millions, FARM databank
USCPI	-	U.S. consumer price index all items, FARM databank

REFERENCES

Andrikopoulos, A., J. Brox and E. Carvalho, "Substitution Demand for Protein Commodities: the Canadian Experience, 1958 to 1981", Canadian Journal of Agricultural Economics 32, 141-50 (1984).

Aykac, M. , M. Corstjens, D. Gautschi, and I Horowitz, "Estimation uncertainty and optimal advertising decisions", Management Science, 35(1), 42-50 (1989).

Canadian Egg Marketing Agency, 1989 Annual Report and other issues.

Chyc, K. and E.W. Goddard, "Optimal Investment in Generic Advertising and Research: The Case of the Canadian Supply Managed Egg Market", Agribusiness: An International Journal, 10(2):145-166 (1994).

Curtin, L., D. Théoret and M. Zaferiou, Demand for Foods in Canada: Recent Estimates. Working Paper WP13/87, Ottawa: Agriculture Canada, 1987.

Dorfman, R. and P.O. Steiner, "Optimal Advertising and Optimal Quality", American Economics Review 44, 826-835 (1954).

Forbes, J.D., D.R. Hughes and T.K. Warley. Economic Intervention and Regulation in Canadian Agriculture. Economic Council of Canada and The Institute for Research on Public Policy, 1982.

Fox, Glenn, Enamul Haque and George Brinkman, "Product Market Distortions and the Returns to Federal Laying-Hen Research in Canada: Reply and Further Results", Canadian Journal of Agricultural Economics, 38, 351-356 (1990).

Green, Christopher, Canadian Industrial Organization and Policy, McGraw-Hill Ryerson Ltd., Toronto, 1985.

Grubel, Herbert G. and Richard W. Schwindt, The Real Cost of the B.C. Milk Board, The Fraser Institute, 1977.

Haque, Enamul, Glenn Fox and George Brinkman, "Product Market Distortions and the Returns to Federal Laying-Hen Research in Canada", Canadian Journal of Agricultural Economics, 37, 29-46 (1989).

Hassan, Z.A. and S.R. Johnson. Consumer Demand for Major Foods in Canada. Economics Branch Publication 76/2, Ottawa: Agriculture Canada, 1976.

Hurst, S. and O. Forker, Annotated bibliography of generic commodity promotion research. Department of Agricultural Economics Publication A.E. Res. 89-26, New York: Cornell University Agricultural Experiment Station, 1989.

Kotowitz, Y. and F. Mathewson, "Advertising, Consumer Information and Product Quality", Bell Journal of Economics, 10(2), 566-588 (1979).

Koutsoyiannis, A., Non Price Decisions: The Firm in a Modern Context, St. Martin's Press, New York, 1982.

Lindner, R.K. and F.G. Jarrett, "Supply Shifts and the Size of Research Benefits", American Journal of Agricultural Economics, 60(1),48-58 (1978).

Lucas, Robert E. Jr., "Econometric Policy Evaluations: A Critique," in The Phillips Curve and Labour Markets, Karl Brunner and Allen H. Meltzer, eds. Amsterdam, North-Holland, 1976.

McCutcheon, M. and E.W. Goddard, Optimal Social Payoff From Generic Advertising -The Case of the Canadian Supply Managed Egg Sector, Dept. of Agricultural Economics and Business Working Paper WP91/10, 1991.

McCutcheon, M. and E.W. Goddard, "Optimal Producer and Social Payoff From Generic Advertising - The Case of the Canadian Supply Managed Egg Sector", Canadian Journal of Agricultural Economics, 4 (1992).

Moschini, Giancarlo and Karl D. Meilke, "Sustainable Rates of Return for Milk Quotas in Ontario", Canadian Journal of Agricultural Economics 36(1), 119-126 (1988).

Nerlove, M. and F.V. Waugh, "Advertising Without Supply Control: Some Implications of a Study of the Advertising of Oranges", Journal of Farm Economics, 43(4), 813-837 (1961).

Ontario Egg Producer's Marketing Board, 1989. Annual Report and other issues.

Perrakis, Stylianos, Canadian Industrial Organization, Prentice-Hall Canada Inc., Toronto, 1990.

Van Kooten, G.C., "Economic Impacts of Supply Management: Review and Comparison of Alternative Measures of Consumer Welfare Loss", Canadian Journal of Agricultural Economics, 36, 425-441 (1988).