OPTIMAL SOCIAL PAYOFF FROM GENERIC ADVERTISING - THE CASE OF THE CANADIAN SUPPLY MANAGED EGG SECTOR

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1. ADVERTISING IN THE CANADIAN EGG MARKET

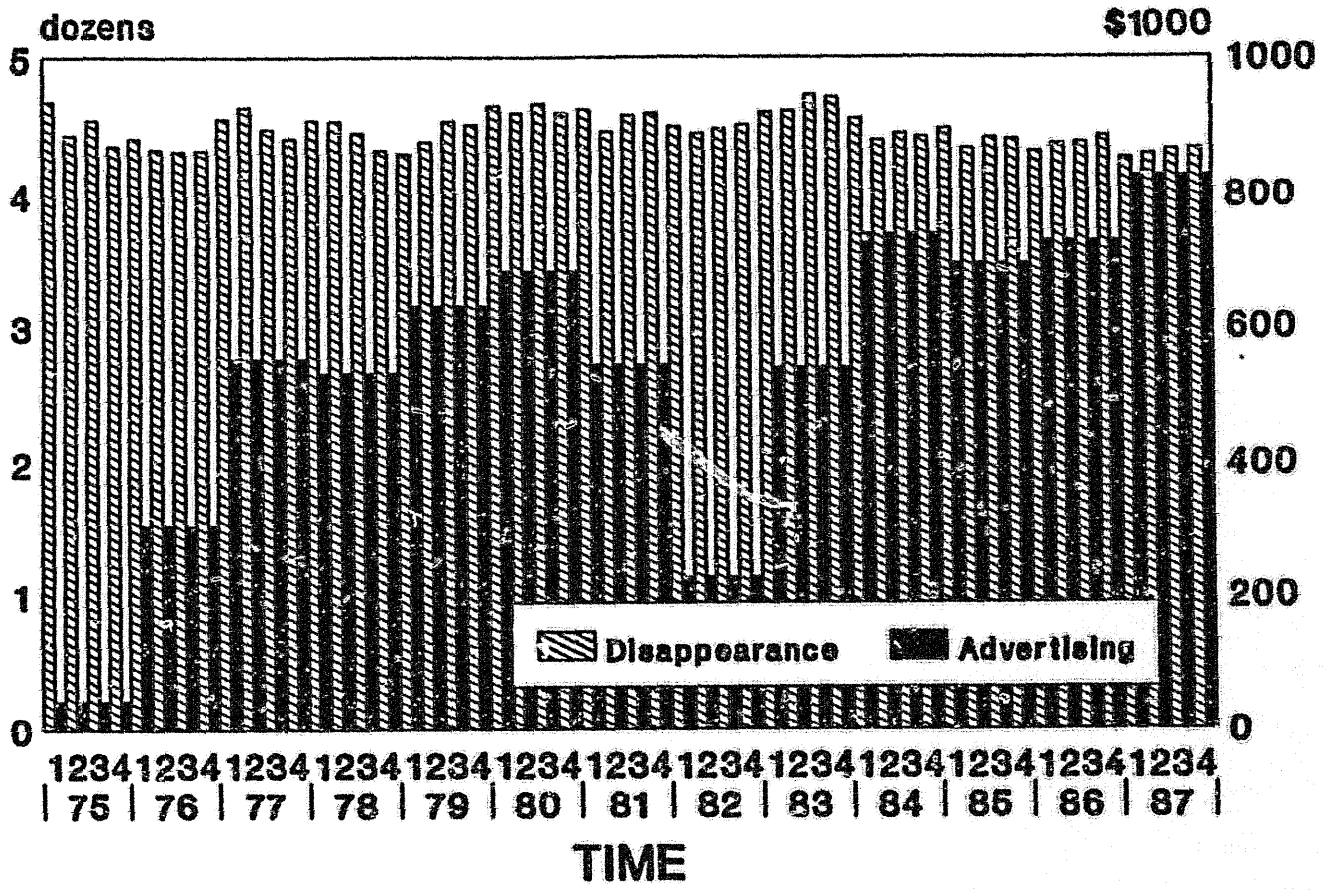
Generic advertising of agricultural commodities in Canada has significantly increased over the past ten years. The Canadian Egg Marketing Agency is no exception and their advertising expenditure has almost doubled since the beginning of the eighties (Figure 1). Most previous research on generic advertising has dealt with the effectiveness of advertising. In general, previous research has found that advertising has been effective in shifting the demand curve to the right thereby increasing demand and/or changing the demand elasticity (for example, Goddard and Tielu).

The objective of this study is to determine the social welfare implications of generic advertising. When a producer group invests in generic advertising their objective is to maximize profit. However, in many cases in the Canadian agricultural sector, advertising is partially subsidized by provincial or federal governments. If the government invests in generic advertising their objective would likely be to improve social welfare. Therefore, the objective of this paper is to determine the impact of advertising expenditure in the Canadian egg market on producers, consumers and social welfare. To this end an econometric model of the Canadian egg market will be estimated and simulated.

In Canada eggs are one of a number of commodities that operate under the auspices of a national marketing agency which practices supply management. Under a supply management system imports of the commodity are controlled. The cost of production for eggs is established and supply is determined on a national level to ensure that producer price covers the cost of production. Provincial quotas are distributed on the basis of historical market share. In general

Figure 1

PER CAPITA DISAPPEARANCE AND ADVERTISING CANADIAN EGGS



prices for eggs are not controlled beyond the farm gate where they are sold fresh or diverted to the breaker market.

The supply management system makes the analysis of the impact of advertising somewhat problematic. The behaviour of the marketing agency in retrospect must be established. To address this issue, a number of assumptions will be made about how the agency might have reacted to market forces. All analyses will be of the form, "what would have happened if advertising expenditures had been changed?"

2. MODEL SPECIFICATION

The Canadian egg market can be graphically portrayed as in the following diagram, Figure 2. The cost of production is established and supply (S_1) is set where the producer price will just cover the costs of production (a price higher than the marginal cost price from the supply curve). Consumption (C_1) and net trade (the difference between S_1 and C_1) will also be established. 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 are freely auctioned or negotiated. This diagram ignores some of the realities in the egg market. In more detail the market can be represented in the following flowchart, Figure 3.

The determination of the producer price leads to the formation of the retail market price for eggs. From the price the retail level consumption of fresh eggs is determined. Given that and the allowance of eggs disappearing to the breaker market (where all surplus is disposed of) the egg supply or production level is determined. A model of this sector will contain;

1. a stochastic retail level per capita demand equation for fresh eggs.
2. a stochastic retail price linkage equation to the producer price of eggs.
3. a stochastic supply equation for eggs.

FIGURE 2: THE CANADIAN EGG MARKET

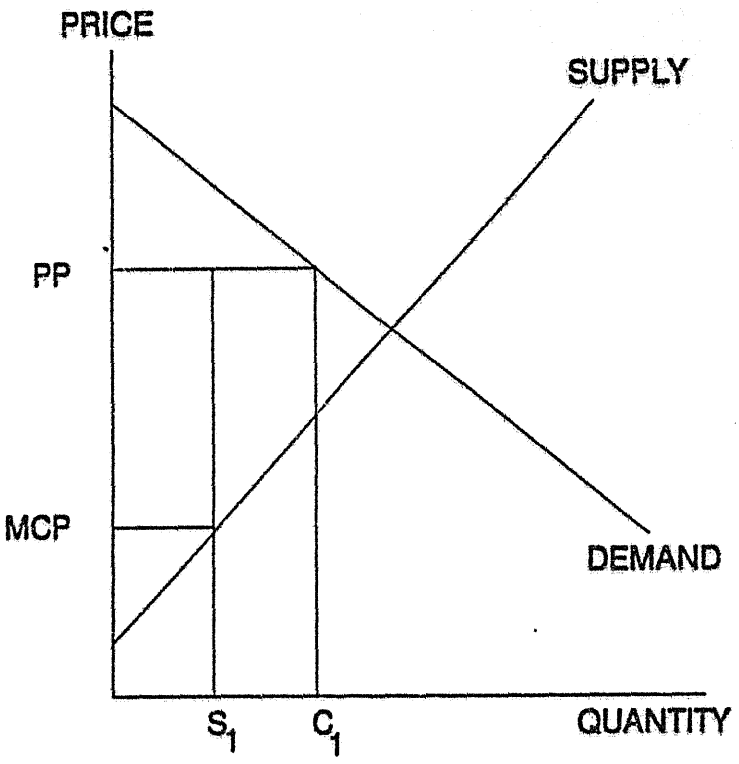
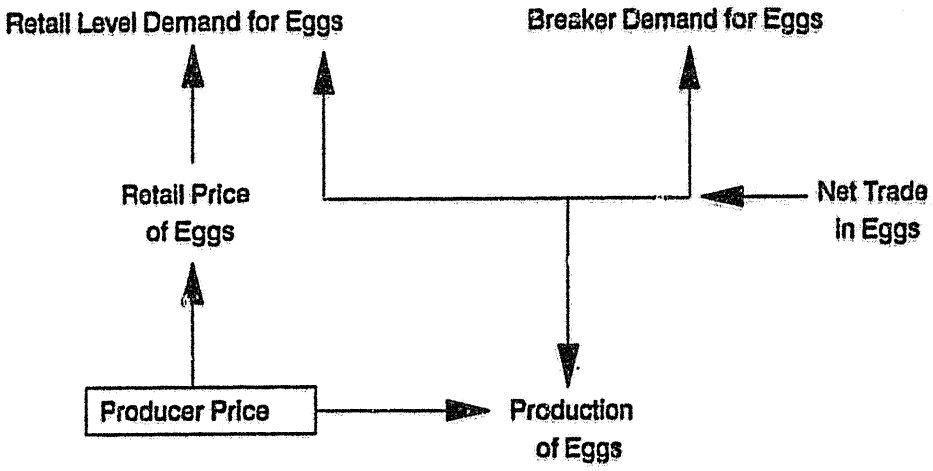


FIGURE 3: OVERVIEW OF THE CANADIAN EGG MARKET



4. an identity ensuring that supply and demand for eggs are equal.

As in most previous advertising effectiveness studies the retail demand for eggs can be expressed as a function of own and cross prices, income and advertising expenditure levels. It is important to note that since advertising expenditure appears in the demand function, consumer theory tells us that it is playing a role in affecting the consumer's marginal utility associated with eggs.

It is somewhat difficult to specify what other commodities may be closely linked to egg demand so cross advertising effects have been constrained to zero. Consumer theory restricts the demand equation to be homogeneous of degree zero in prices and income. Additionally, in establishing optimal advertising expenditure levels, the demand equation must be twice differentiable with respect to advertising.

The approach used in this research has been to estimate the quarterly consumption of eggs from 1979 to 1987 under an expenditure dependent logarithmic demand equation. The form used imposes constant elasticities along the demand curve. Quarterly consumption is measured from 1979 to 1987 using expenditure as the dependent variable in the equation. The demand equation will have the following form;

retail expenditure on fresh eggs	=	f(retail per capita consumption of eggs, income, advertising, seasonal dummies, lagged dependent variable)

Note that advertising, price, income and expenditure are all in logarithmic form. Homogeneity is imposed in the equation by deflating prices, advertising and income by the Consumer Price Index. The advertising variable is the log of the reciprocal of advertising expenditure in order to make the equation twice differentiable in advertising. A time trend is also included to account for structural change on demand arising possibly from health concerns.

The 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 were 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. Given supply controls it is reasonable to estimate the supply curve as price dependent. The supply equation will have the following form:

Marginal Cost of Eggs = f(Supply of Eggs, Price of Laying Mash, Seasonal Dummies, Lagged Dependent Variable)

The retail mark-up equation will be a direct mark-up from the producer price of eggs and will have the following form:

Retail Price of Eggs = f(Producer Price of Eggs, Seasonal Dummies, Lagged Dependent Variable)

The lagged dependent variable is included to account for partial adjustment in pricing eggs.

The model is closed by two identities as follows:

Marginal Cost of Eggs = Producer Price - Quota Value

Supply of Eggs = Consumption + Breaker Egg Demand

The structural model of the Canadian egg industry can be used to examine the implications of optimal advertising expenditures on producer welfare and social welfare. Optimal advertising expenditure will be determined using the Dorfman-Steiner rule (1954) for optimal investment in advertising by a monopolist for the case of either fixed supplies or fixed prices.

3. DATA

Data on disappearance, production, breaker egg demand and net trade of eggs and prices were obtained from the Agriculture Canada Farm databank. The retail price of eggs was in index

form and therefore a conversion was made to dollars by multiplying by $1.26 (a 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.

The following is a list of all data used and the acronyms used throughout the analysis and the rest of this paper.

rpeggs - retail price of eggs ¢/dozen

ppeggs - producer price of eggs ¢/dozen

mcpe - marginal cost price of eggs ¢/dozen (ppeggs - sqr)

sqv - static quota value ¢/dozen

q1, q2, q3 - seasonal dummies

time - time trend (accounts for technological or structural change)

pcegg - per capita egg consumption = supply - net trade - breaker egg usage

eexp - expenditure on eggs

qsm - supply managed quantity of eggs produced

pcdi - per capita income

plm3 - price of laying mash

ade - 1/per capita advertising expenditure by the Canadian Egg Marketing Agency

4. ESTIMATED RESULTS

Estimation of empirical equations was done using Ordinary Least Squares Regression in TSP Version 4.1. Table 1 presents the expenditure dependent logarithmic demand equation results. The estimated supply and processor demand equations are presented in Table 2. The calculated elasticities are of theoretically correct signs and reasonable magnitudes.

Table 1
Egg Demand

Dependent Variable: Log of Expenditure on Eggs

Variables[1/]	Coefficient	t-Stat	Flexibilities (short run, long run)	
Constant	6.7775	2.3512**		
PCEGG*Time	0.1150	1.4447	(-0.885)	(-24.73)
PCD1	-0.75848	-2.1810**	(-0.758)	(-21.19)
ADE(-2)	-0.043994	-2.1669**	(0.044)	(1.23)
Q1	-0.13292	-8.0820**		
Q2	-0.03915	-2.7379**		
Q3	-0.03737	-2.4246**		
EEXP(-1)	0.96482	16.576**		
Rho	-0.2587	-1.5424		

R^2 0.992
D.W. Statistic 2.0982
F Statistic (7,32) 552.806
** Significant at 95% level.

1/ All variables are in natural logs.

Table 2

A: SUPPLY EQUATION
Dependent Variable: Marginal cost price for eggs

Variable	Coefficient	t-Stat	Elasticities
Constant	82.093	6.2725**	
PLM3	0.033487	1.3603	0.101
SEGG1	0.26488×10^{-6}	2.0591**	0.385
Time	-0.7899	-6.7125**	
Q1	-1.1346	-2.5397**	
Q2	-1.6070	-3.1493**	
Q3	-1.3519	-2.9582**	
RHO	0.787512	8.1524**	

R^2 = .960
D.W. Statistic = 2.07
F-Statistic (6,34) = 113.85

B: PRICE LINKAGE
Dependent Variable: Retail Price of Eggs

Variable	Coefficient	t-Stat	Elasticities
Constant	12.669	7.1298**	
PPEGGS	0.81195	13.863**	0.577
Q1	-0.66731	-1.8902*	
Q2	-0.92026	-2.6049**	
Q3	0.33661	0.95062	
RPEGGS(-1)	0.31199	5.9714**	

R^2 = 0.994
D.W. Statistic = 1.5164
F-Statistic (5,34) = 1419.04
** significant at 95% level
* significant at 90% level

5. MODEL SIMULATION

The estimated equations were combined with the necessary identities to close the model and were simulated over the historical period 1980 to 1987. Validation statistics were reasonable for the model and are reported in Table 3. The base model assumes that supply is an exogenous policy-determined variable and solves for per capita consumption, retail price, producer price, quota value and marginal cost price for eggs.

One of the major problems in modelling a supply managed market is the lack of quantifiable data on how the "supply" decision is formulated. In a base model it is sufficient to capture what has happened in a market and to assume that "supply" is a purely exogenous variable. In the scenarios where market forces are shocked this exogeneity of supply or lack of definition of how the marketing agency responds in the short run to changing market forces causes problems in economic analysis. To circumvent this problem three alternate scenarios were developed.

The first scenario is that supply would have been the same regardless of advertising expenditure. If the market without advertising were as in Figure 4 and supplies remain unchanged a shift in the demand curve due to advertising would result in higher retail price, producer price, quota value and unchanged supply and marginal cost price. In this scenario consumer surplus moves from ABC to DEF but does not necessarily increase and producer surplus changes from GHJK to MNJK.

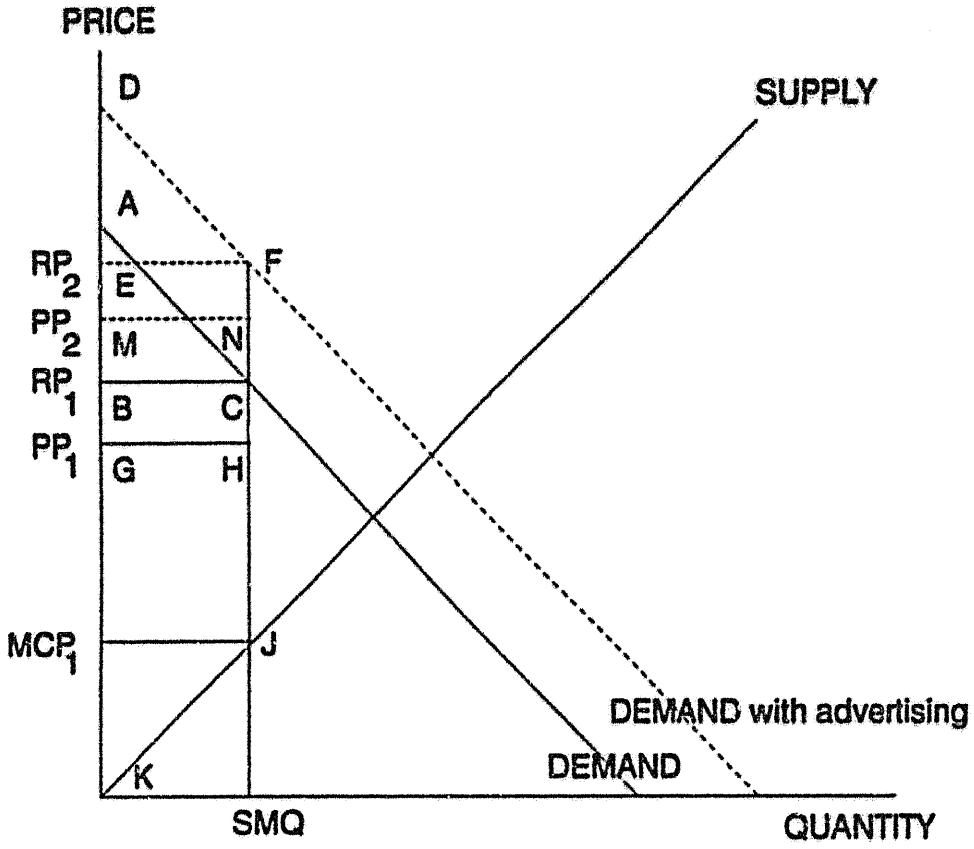
An alternate scenario would have as the industry's objective, to maintain quota values with advertising expenditure, at the same level as they were in the absence of advertising expenditure. This scenario could be portrayed as in Figure 5. The scenario would result in increased quantity produced, increased retail, producer and marginal cost price and unchanged quota values.

Table 3
Validation Statistics: Base Simulation

Time Period 1980 to 1987

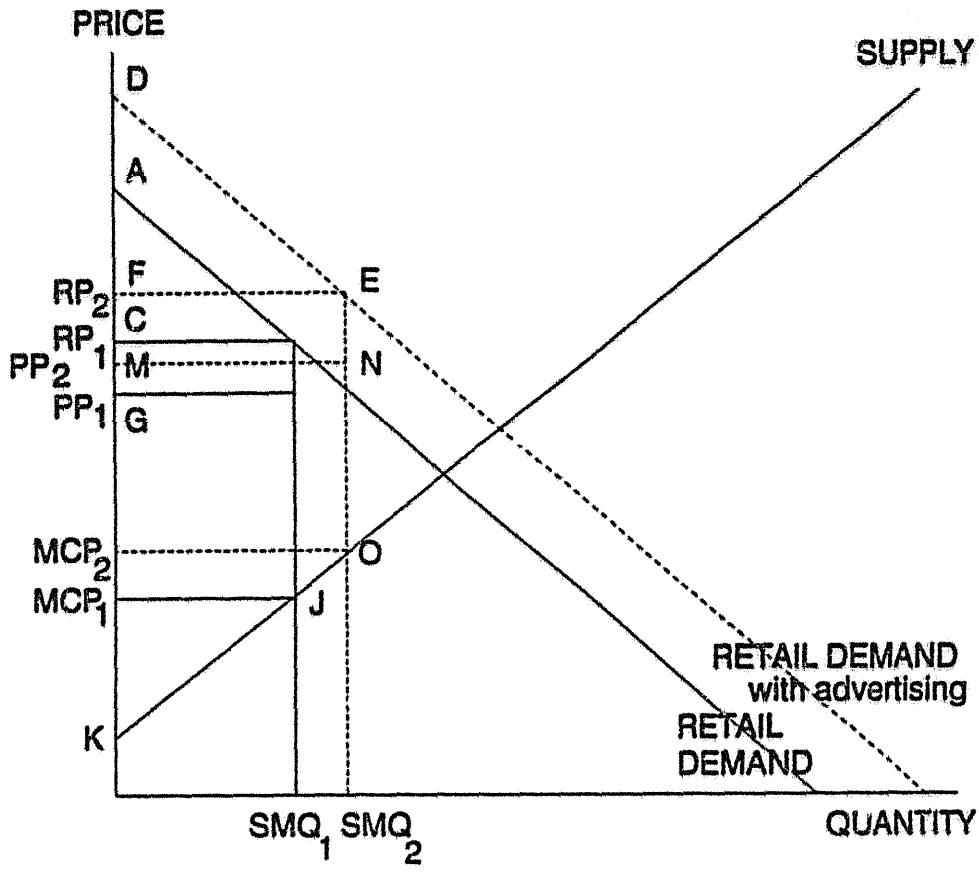
Variable	Mean	RMSE	RMSPE(%)	Correlation Coefficient
Retail Price of Eggs	109.343	2.87459	2.63	0.96538
Producer Price of Eggs	77.076	3.05081	3.96	0.94078
Marginal Cost Price	65.116	2.38603	3.66	0.96133
Quota Value	11.960	4.22541	35.33	0.15801

FIGURE 4: EFFECT OF ADVERTISING ON A SUPPLY MANAGED COMMODITY WITH EXOGENOUS SUPPLY



RP - Retail Price
PP - Producer Price
SMQ - Supply Managed Quantity

FIGURE 5: EFFECT OF ADVERTISING ON A SUPPLY MANAGED COMMODITY WITH EXOGENOUS QUOTA VALUES



RP - Retail Price
PP - Producer Price
MCP - Marginal Cost Price
SMQ - Supply Managed Quantity

Consumer Surplus moves from ABC without advertising to DEF with advertising. producer surplus moves from GHJK without advertising to MNOK with advertising. Whether consumer and producer welfare increase or not is not obvious from the diagram and must be estimated.

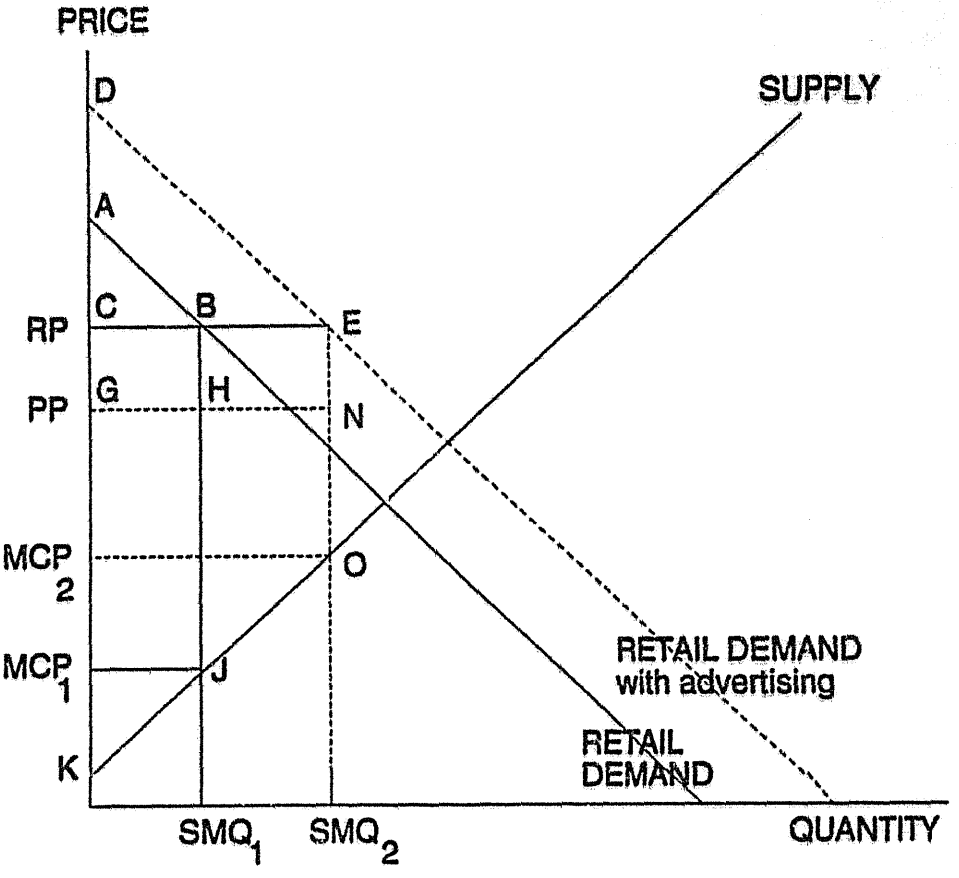
A third scenario would have as the industry's objective, to maintain producer egg prices with advertising expenditure, at the same level as they were in the absence of advertising expenditure. This scenario could be portrayed as in Figure 6. The scenario would result in increased production and marginal cost price, unchanged producer and retail prices and a decrease in quota values with advertising expenditure. Consumer surplus would move from ABC to DEC with advertising. Producer surplus would move from GHJK to GNOK with advertising.

It is worth stressing that these three scenarios are arbitrarily selected and may not, in fact, represent realistic reactions by national marketing agencies. They seem, however, to outside analysts to be reasonable responses to economic shocks.

5.1 Determination of Optimal Advertising Expenditure Levels

Given the estimated statistically significant response to advertising expenditure levels (Table 1) and three possible scenarios of how the egg market may respond to changes in the level of advertising expenditure the determination of optimal advertising expenditure becomes critical. The Dorfman-Steiner condition applies to the case of a monopolist with control over supply/price and advertising expenditure levels (which are assumed to represent a fixed cost to the monopolist). In many ways this applies directly to the case of generic advertising by the Canadian Egg Marketing Agency. However, in the case where governments are involved in supporting advertising expenditure the optimization criteria may differ from the monopolist's aim of maximizing profits. Although much research is currently being undertaken to define and measure the operational criteria of government bodies, for the purposes of this exercise it may be sufficient

FIGURE 6: EFFECT OF ADVERTISING ON A SUPPLY MANAGED COMMODITY WITH EXOGENOUS RETAIL & PRODUCER PRICES



RP - Retail Price
PP - Producer Price
MCP - Marginal Cost Price
SMQ - Supply Managed Quantity

to assume that governments operate to maximize social welfare. The question becomes, whether or not, optimal advertising expenditure levels would differ if the government chose to maximize social welfare or if a monopolist chose to maximize profits.

In reality, it is easily shown (see Appendix 1) that for each of the three individual scenarios previously discussed, there is no difference between the level of advertising expenditure a monopolist would choose and that a government with a slightly different objective function would choose. Consumer and producer surplus in total are maximized at the same point as producer surplus is maximized. However, across scenarios the social versus private welfare implications may differ. The optimal advertising expenditure level and choice of scenario for a monopolist versus a government is essentially an empirical question. For a particular year's data, the question is assessed in the context of the Canadian egg market below.

5.2 Optimal Advertising Expenditure Levels in the Canadian Egg Market

The results of applying optimal advertising expenditure criteria under each of the three scenarios are found in Table 4 for 1987 average data. The Dorfman-Steiner condition is applied in a long-run static scenario (the two quarter lag on advertising expenditure response is assumed to be a current period response).

As expected retail and producer prices and quota values rise as advertising is increased with fixed sales. With sales allowed to increase quota values can fall. Social welfare increases across all scenarios but increases the most with fixed quantities sold. This is in direct response to the changes in producer surplus which includes rent to the quota. Most surplus accruing under this scenario would be bid away in quota values by new entrants to the industry. Existing producers would reap the benefits. It is worthwhile noting that producer welfare, the producer surplus as measured under the marginal cost price, does not change in this scenario which maximizes profit.

Table 4
Results from Optimal Advertising Expenditure Levels (1987)

	BASE	Scenario 1 Fixed Supply	Percent Change	Scenario 2 Fixed Quota Value	Percent Change	Scenario 3 Fixed Retail Price	Percent Change
Supply of eggs eggs (doz x 10^8)	1.03	1.03	0	1.11	7.7	1.14	10.3
Per capita consumption of eggs (doz)	3.51	3.51	0	3.82	8.8	3.92	11.85
Producer Price (¢/doz)	68.26	77.25	13.3	70.38	3.2	68.26	0
Retail Price (¢/doz)	98.74	107.73	9.2	100.83	2.1	98.74	0
Quota Value (¢/doz)	14.87	23.86	63.5	14.87	0	12.02	-20.5
Marginal Cost Price (¢/doz)	53.38	53.38	0	55.51	4.0	56.23	5.4
Advertising Expenditure ('000 $)	598	1363	127.9	1351	125.9	1347	125.2
Consumer Surplus* ($x10^8$ $)	8.09	8.35	3.2	8.41	3.8	8.42	4.0
Producer Surplus** ($x10^7$ $)	2.93	3.87	32.3	3.28	11.9	3.06	4.5
Social Welfare*** ($x10^8$ $)	8.38	8.72	4.1	8.72	4.0	8.72	4.0

* measured as the area underneath the Marshallian demand curve and above the producer price of eggs.
** measured as the area above the supply curve and underneath producer price.
*** sum of producer and consumer surplus - advertising expenditure.

The results would suggest that either market participant, producers or the government, would invest in advertising to the same level under the same optimal scenario. Government involvement in the advertising activity is thus questionable.

6. CONCLUSIONS

The analysis of the impact of advertising in a market with government intervention is problematic. Several scenarios for the impact of advertising were suggested and analyzed. In the case examined social welfare implications do not vary significantly across scenarios. This suggests that in regulated markets any government involvement in generic advertising should be carefully tied to the regulations governing the industry. Given that for individual scenarios social welfare maximization and profit maximization result in the same level of advertising expenditure and resulting quantity supplied and price the question of any government involvement in advertising becomes relevant. It is clear from the results however, that consumer surplus changes are largest from scenario three (fixed prices) and producer surplus changes are largest from scenario one (fixed quantity). While these results are not surprising it may be that government contribution to an advertising activity for a monopolistic industry might be appropriate to compensate the industry for accepting solutions (ie. fixed price) that do not achieve the maximum producer surplus.

The results reported here are preliminary and give an example of how advertising effectiveness can be established in an economic model. The results suggest that advertising is effective in shifting the demand for eggs and providing both consumers and producers with additional welfare. However without further examination of the demand for eggs in a wider context that includes other commodities these results can not be considered robust.

Further analysis is essential to establish the exact return on investment from optimal advertising expenditure levels. A better picture of how supply is determined in the egg market is essential if optimal investment in advertising is to be determined conclusively for the industry.

REFERENCES

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

Goddard, E.W. and A. Tielu 1983. Assessing the Effectiveness of Fluid Milk Advertising in Ontario, Canadian Journal of Agricultural Economics, 36, pg. 261-278.

APPENDIX I

OPTIMAL INVESTMENT IN ADVERTISING

With a simple example it is possible to show the derivation of optimal advertising expenditure levels for both producers and society. The application is for a monopoly with control over price/quantity and advertising expenditure levels where advertising is assumed to be a fixed cost for the producer optimum (assumptions the same as Dorfman and Steiner (1954)). For the social optimum the government is operating to maximize social welfare (consumer surplus plus producer surplus) for a monopoly with control over price/quantity and advertising is again assumed to be a fixed cost.

If the demand and supply equations for a hypothetical industry can be represented as follows:

$$\text{DEMAND, } P = A - B \times Q + E \times AD^2 \qquad (1)$$

$$\text{SUPPLY, } P = C + D \times Q \qquad (2)$$

where P = price, Q = quantity, AD = advertising expenditure and A, B, E, C, D are coefficients, then the Dorfman-Steiner condition can be applied.

The Dorfman-Steiner condition states that at optimal advertising expenditure levels:

$$-\frac{\partial Q}{\partial P}\frac{P}{Q} = \frac{\partial Q}{\partial A} P \quad . \qquad (3)$$

The above demand equation (1) can be inverted to give

$$Q = \frac{A}{B} + \frac{E}{B} AD^2 - \frac{1}{B} P \quad .$$

From (3)

$$-\frac{\partial Q}{\partial P}\frac{P}{Q} = \frac{1}{B}\frac{P}{Q} \text{ and}$$

$$\frac{\partial Q}{\partial AD} P = \frac{2EAD \quad P}{B} \quad .$$

Equating the two and solving for AD gives:

$$AD = \frac{1}{2EQ} \quad , \tag{4}$$

the optimal advertising expenditure level for a monopolist.

To maximize social welfare from advertising the area under the demand curve minus the area under the supply curve must be maximized. Therefore, social welfare can be proxied as:

$$SW = \int_0^Q (A - BQ + EAD^2)\ \partial Q - \int_0^Q (C + DQ)\ \partial Q - AD \quad .$$

To maximize SW the first derivative with respect to AD is taken, equated to zero and solved for AD

$$\frac{\partial SW}{\partial AD} = 2E\ AD\ Q - 1$$

$$\therefore\ AD = \frac{1}{2EQ} \quad . \tag{5}$$

In the simple example given the optimal advertising expenditure level is the same for the monopolist as it is for the government in the same industry. The rationale for government involvement in advertising, in the particular case shown, is therefore in the nature of a subsidy to the industry. Its efficacy should be established relative to other possible forms of subsidy to the relevant industry.

1. OPTIMAL ADVERTISING IN THE EGG MODEL

The three stochastic equations previously estimated can be represented as follows:

$$RPEGGS = RR + R1 * PPEGGS \quad \text{(retail egg price equation)}$$

$$MCPE = SS + S2 * QSM \quad \text{(marginal cost price supply equation)}$$

$$EEXP = AA * ADE^{D3} * PCEGG^{D3} \quad \text{(retail expenditure equation)}$$

where RR, SS, AA represent all variables excluded from the above simplification and R1, S2, D3, D1 are estimated coefficients reported in Tables 1 and 2.

To close the model the following identities are required:

$$QSM = PCEGG * Population + Net\ trade + Breaker\ Egg\ Usage$$

$$MCPE = PPEGGS - SQV$$

From these five relationships it is possible to collect terms and represent the egg market by the following (producer) price-dependent supply and demand equations:

$$(1)\ DEMAND : PPEGGS = \frac{AA}{R1} * (ADE^{D3}) * PCEGG^{D1-1} - \frac{RR}{R1}$$

$$(2)\ SUPPLY : PPEGGS = SS + S2 * (PCEGG * POPULATION) + SQV$$

These reduced form equations provide the basis for calculating optimal advertising levels under maximization of social welfare or producer welfare.

Producer Profit Maximization

From Dorfman and Steiner (1954) optimal advertising expenditure occurs where the marginal value product of advertising (MVPA) is set equal to the negative of the own price elasticity of demand (PELAS)

From the demand equation (1) is can be shown that:

$$PCEGG = \left[\frac{AA * ADE^{D3}}{RR + R1 * PPEGGS}\right]^{\frac{1}{1-D1}},$$

and $MVPA = PPEGGS * \frac{\partial PCEGG}{\partial ADE}$,

$$PELAS = \frac{PPEGGS}{PCEGG} * \frac{\partial PCEGG}{\partial PPEGGS} .$$

Therefore $ADE = \frac{PCEGG * D3 * (RR + R1\ PPEGGS)}{- R1}$

After substituting in for PPEGGS from (1) then the optimal advertising expenditure level can be determined as:

$$ADE = \left[\frac{(-D3) * AA * PCEGG^{D1}}{R1}\right]^{\frac{1}{1-D3}}$$

Since producer profit maximization results in the same optimal level of advertising as the social welfare maximization case the above level of ADE is optimal both for society and for producers.