ECONOMIC ANALYSIS OF MEAT PROMOTION

PROCEEDINGS FROM THE NEC-63 CONFERENCE

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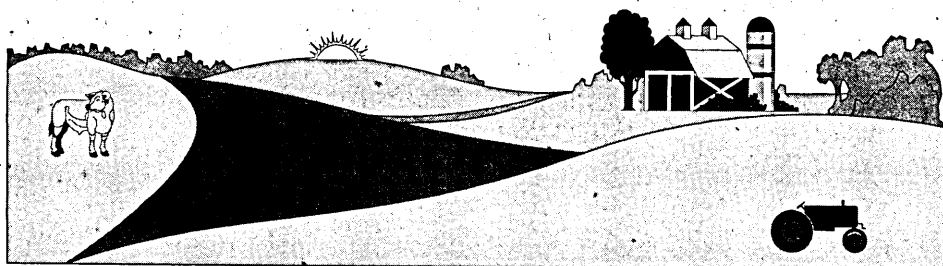Henry W. Kinnucan
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10

THE BENEFITS TO CANADIAN HOG PRODUCERS OF GENERIC VS. BRAND ADVERTISING OF PORK

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The pork market in Canada is characterized by generic (fresh pork) and brand (ham, bacon, sausage and wieners, other processed pork) advertising. In this study the economic interrelationships in the consumption of pork products are examined to determine which product's advertising is the most effective at increasing producer surplus from production of hogs. A two-stage demand model consisting of a single equation determining Canadian aggregate per capita expenditure on pork and a linear approximate AIDS expenditure share system for five products: fresh pork, ham, bacon, sausage and wieners, and other processed pork is estimated. The demand relationships are combined with supply and North American price linkage relationships to simulate returns to individual pork product advertising. Branded ham and generic fresh pork advertising were found to return Canadian hog producers the greatest producer surplus increase.

Introduction

Producer marketing organizations traditionally undertake "generic" advertising while private companies undertake "branded" advertising. The objectives of this research are to determine the impact of generic and branded advertising on the retail demand for pork and pork products in Canada and determine for marketing boards an advertising strategy which achieves the greatest net benefit (revenue - costs - advertising expenditure) for member producers. Should marketing boards be advertising generic pork or specific generic pork cuts or both? Alternatively, would producers be made better off if boards assisted pork processors and packers with branded pork advertising?

Inclusion of Advertising in Demand Systems

It is important to clearly define the advertising variable when attempting to measure the impact of advertising on commodity demand. Three approaches have been used in the literature. Studies have defined the advertising as only generic advertising expenditure (Green, Carman and McManus 1991; Goddard and Tielu 1988; Chang and Kinnucan 1990). This may overestimate the impact of generic advertising if branded advertising is significant in the market. Other studies have aggregated generic and branded advertising expenditure (Brester and Schroeder 1994). This assumes that the response to advertising is the same for generic and branded advertising. This likely is not the case. The final approach is to attempt to treat generic and branded advertising as separate variables (Jones and Ward 1989; Goddard and Amuah 1989; Ward 1988). This is the best approach to use because interrelationships between products within a category can be considered. Little published research has examined impacts of meat advertising on meat demand (Brester and Schroeder 1994) and there are even fewer examples at a disaggregated product level (eg., ham, fresh pork, bacon as opposed to all pork).

Methodology

A consumer is assumed to allocate their meat and pork expenditure budget in a certain manner. For the purposes of this study, the following chart shows the assumed budget allocation of a consumer. The consumer allocates a certain part of their budget to beef, pork and chicken. The consumer then allocates their pork expenditure budget to 5 pork categories. A limiting assumption in this study is that of weak separability between the consumption of individual pork products at the second stage and consumption of all other meat at the first stage.
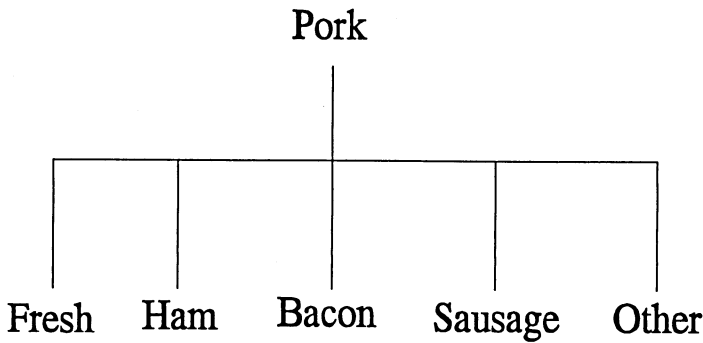

Figure 1. Decision Tree for Consumer's Pork Expenditure Budget

This study examines the effectiveness of "generic" and "brand" advertising of pork and pork products in Canada from 1970-1992. One generic and four branded pork advertising categories were examined. The pork product categories include fresh "generic" pork, ham, bacon, sausage and wieners, and all other processed "branded" pork (mainly luncheon meat). Sausage and wieners are products which may contain a large percentage of pork. We assume that a consumer spends only a certain percentage of their budget on pork and we are concerned with whether advertising "generic" fresh pork or "branded pork products" can increase total expenditure on pork by a consumer and/or the budget share allocation within the pork expenditure category. In other words, can advertising a relatively higher priced pork product (eg. ham) make the consumer buy more ham and maybe more pork in total or will the consumer buy more ham and less bacon, fresh, sausage and wieners and other processed pork? If this advertising causes ham demand to increase (and maybe total pork demand) could this be of benefit to pork producers in terms of additional producer surplus?

A linear approximate version of the AIDS (Almost Ideal Demand System) developed by Deaton and Muellbauer (1980) is used to estimate annual per capita Canadian demand for pork products. The first stage of the system is:

$$\log(\text{TEXP}) = C + D * \text{PSTAR} + F * \text{ASTAR} + G * \log(\text{PDI}) + H * TIME \tag{1}$$

where:

$$PSTAR = \sum_i w_i * LOG(p_i) = \text{Stone's price index}$$

$$ASTAR = \sum_i w_i * LOG(adv_i)$$

w_i =   budget share for good i
adv_i =   advertising expenditure for good i
p_i =   price of good i
TEXP =   total expenditure on pork
PDI =   personal disposable income
TIME =   time trend
i,j =   1 to 5

The second stage of the system is:

$$w_i = A_i + X_i * TIME + \sum_j Z_{ij} * \log(adv_j) + \sum_j U_{ij} * \log(p_j) + B_i * \frac{\log(TEXP)}{PSTAR} \qquad (2)$$

The advertising variable in the first stage should be an aggregate measure of the advertising variables at the second stage (Goddard and Conboy, 1993). ASTAR was deemed to be an appropriate measure.

Data

Annual data from 1971 to 1992 were used for the study. All data were deflated by the consumer price index. Data on shipments, exports, imports, and stocks of pork products were obtained from Statistics Canada. Prices for the individual products were calculated as implicit prices (value of shipments/quantity of shipments). Data on population and personal disposable income were obtained from Statistics Canada. The data for advertising expenditures for each product (fresh pork, ham, bacon, sausage and wieners, other processed pork) were obtained from annual data on media advertising expenditures by commodity, compiled by Media Measurement Services. The advertising expenditure is the aggregation of television, newspaper, radio and magazine. This implies that consumers respond in the same way to an advertisement from any of these media.

Estimation Results

Time Series Processor (TSP) version 4.2B was used in the analysis. The first stage single equation and second stage system of expenditure share equations are estimated simultaneously using non-linear least squares (LSQ). The five dependent variables at the second stage sum to one by definition so the expenditure share equation for other processed pork was dropped from the estimation to make estimation easier.

The results of the first stage and second stage equations are reported in Table 1. The weighted average price of pork products, weighted average advertising expenditure by product, and time trend coefficients were found to be significant at the 10% level. The coefficient on personal disposable income was not significantly different from zero. Of particular interest is the response

Table 1. Parameter Estimates for Two Stage Model

Variable	Estimate	T-Statistic
A1	-0.205	-0.659
X1	-0.011	-3.889
Z11	0.013	1.673
Z12	-0.0048	-1.007
Z13	0.0022	0.127
Z14	0.0026	0.166
Z15	0.054	1.675
U11	-0.057	-0.762
U12	0.040	0.837
U13	-0.021	-1.047
U14	0.056	1.449
B1	0.280	3.247
A2	0.078	0.567
X2	0.0067	5.333
Z21	-0.0087	-2.431
Z22	0.0055	2.585
Z23	-0.0071	-0.900
Z24	0.018	2.293
Z25	-0.020	-1.400
U22	-0.011	-0.220
U23	0.0010	0.055
U24	-0.0074	-0.385
B2	-0.0050	-0.129
A3	0.207	3.326
X3	0.00056	1.021
Z31	-0.00018	-0.109
Z32	-0.00043	-0.444
Z33	-0.00056	-0.161
Z34	-0.0018	-0.500
Z35	-0.00055	-0.089
U33	0.062	5.793
U34	-0.024	-2.786
B3	-0.032	-1.874
A4	0.669	2.450
X4	0.0078	3.300
Z41	-0.0061	-0.845
Z42	0.0024	0.547
Z43	-0.00049	-0.031
Z44	0.014	1.070
Z45	-0.039	-1.413
U44	0.024	0.710
B4	-0.213	-2.865
C	4.887	1.156
D	0.259	2.046
F	0.100	4.305
G	-0.029	-0.070
H	-0.019	-2.264

Table 1 continued

Note: second stage   first stage
    A - intercepts   C - intercept
    X - time coefficients   D - price coefficient
    Z - advertising coefficients   F - advertising coefficient
    U - price coefficients   G - personal disposable income coefficient
    B - real income coefficients   H - time coefficient

to advertising. There is significant response to advertising suggesting that the advertising effects at the second stage may lead to increased total pork consumption at the first stage.

The second stage of the demand system was estimated simultaneously with the first stage. The model is reported with the advertising variables lagged one year. Testing of the model with current levels of advertising was unsuccessful in terms of generating statistical significance. Estimated parameters and t-statistics are reported in Table 1. None of the individual advertising coefficients, with the exception of three of the ham advertising coefficients (Z21, Z22, Z24), are significantly different from zero at a 10% level.

The results in terms of price, expenditure, substitution, and advertising elasticities are reported in Tables 2, 3, 4 and 5. The model (price, advertising, income and time) has symmetry and homogeneity automatically imposed on price effects, and adding up automatically imposed on all variables. This follows consumer theory (Green 1971). The model was selected on the basis of likelihood ratio tests, elasticities and the goodness of fit of the estimated equations. The elasticities are calculated at the mean and at the second stage.

Elasticities

Prices and advertising expenditure are assumed to affect both the individual expenditure shares at the second stage and total expenditure on pork at the first stage. Because of this elasticities are calculated across both stages. The formulas used in the study for own-price, cross-price and own- and cross-advertising elasticities are (where w is the expenditure share):

own-price   (3)

$$\left(\frac{\partial w_i}{\partial p_i} * \frac{p_i}{w_i} - 1\right) + \left(\left(\frac{\partial w_i}{\partial TEXP} * \frac{TEXP}{w_i} + 1\right) * \frac{\partial TEXP}{\partial p_i} * \frac{p_i}{TEXP}\right) = (U_{ii}/w_i) - B_i + (B_i/w_i + 1)*D*w_i - 1$$

cross-price   (4)

$$\left(\frac{\partial w_i}{\partial p_j} * \frac{p_j}{w_i}\right) + \left(\left(\frac{\partial w_i}{\partial TEXP} * \frac{TEXP}{w_i} + 1\right) * \frac{\partial TEXP}{\partial p_j} * \frac{p_j}{TEXP}\right) = (U_{ij}/w_i) - (B_i*w_j/w_i) + (B_i/w_j + 1)*D*w_i$$

own- and cross-advertising   (5)

$$\frac{\partial w_i}{\partial ADV_j} * \frac{ADV_j}{w_i} + \left(\frac{\partial w_i}{\partial TEXP} * \frac{TEXP}{w_i} + 1\right) * \frac{\partial TEXP}{\partial ADV_j} * \frac{ADV_j}{TEXP} = (Z_{ij}/w_i) + (B_i/w_i + 1)*F*w_j$$

Expenditure and substitution elasticities are calculated at the second stage using the following formulas:

expenditure
$$\frac{\partial w_i}{\partial TEXP} * \frac{TEXP}{w_i} + 1 = B_i/w_i + 1 \qquad (6)$$

own-substitution
$$\frac{\partial w_i}{\partial p_i} * \frac{p_i}{w_i} * \frac{1}{w_i} + \frac{\partial w_i}{\partial TEXP} * \frac{TEXP}{w_i} - \frac{1}{w_i} + 1 = (U_{ii}/(w_i*w_i))-(1/w_i)+1 \qquad (7)$$

cross-substitution
$$\frac{\partial w_i}{\partial p_j} * \frac{p_j}{w_i} * \frac{1}{w_j} + \frac{\partial w_i}{\partial TEXP} * \frac{TEXP}{w_i} + 1 = (U_{ij}/(w_i*w_j))+1 \qquad (8)$$

Price Elasticities

From Table 2 all of the own price elasticities are negative and statistically significant with the exception of the other branded pork category. The majority of the cross-price elasticities are positive which suggests substitution product relationships between the 5 categories. This means that consumption of individual products will increase due to increased prices of one or more of the other pork product categories.

Table 2. Both Stages Price Elasticities

Elasticity of the Dependent Variables	With Respect to the Price of:				
	Fresh	Ham	Bacon	Sausage	Other
Fresh	-1.19 (-5.94)	0.32 (1.91)	0.26 (1.59)	0.40 (2.43)	0.23 (1.38)
Ham	0.30 (1.27)	-0.99 (-3.65)	0.08 (0.71)	0.03 (0.26)	-0.06 (-0.28)
Bacon	-0.02 (-0.16)	0.09 (0.65)	-0.46 (-5.76)	-0.10 (-1.40)	-0.06 (-0.50)
Sausage	0.84 (4.28)	0.18 (1.30)	-0.009 (-0.17)	-0.66 (-2.81)	-0.12 (-1.04)
Other	0.004 (0.02)	-0.07 (-0.29)	-0.05 (-0.48)	-0.24 (-1.88)	-0.21 (-0.63)

Note: Numbers in parentheses are the t-values for the elasticity estimates.

From Table 3 all of the pork products, with the exception of sausage, seem to be substitutes. This could be due to consumers spending a relatively fixed proportion of their budget on pork products. As the price of one product increases, substitution for one or more of the other product categories will occur to maintain total expenditure at a certain level.

The price elasticities compare favourably to those found in other meat advertising studies (Brester and Schroeder, 1994; Goddard and Griffith, 1992).

Table 3. Substitution Elasticities

Elasticity of the Dependent Variables	With Respect to the Price of:				
	Fresh	Ham	Bacon	Sausage	Other
Fresh	-2.15 (-3.88)				
Ham	1.60 (2.24)	-4.81 (-3.32)			
Bacon	0.58 (1.43)	1.04 (1.36)	-2.98 (-4.99)		
Sausage	1.92 (3.02)	0.75 (1.18)	-0.08 (-0.21)	-4.16 (-3.40)	
Other	0.67 (0.89)	0.16 (0.13)	0.08 (0.10)	-0.94 (-1.23)	-0.86 (-0.41)

Note: Numbers in parentheses are the t-values for the elasticity estimates.

Advertising Elasticities

Table 4 shows advertising elasticities across both stages. All of the own-advertising elasticities are positive. The only own-advertising elasticities that are significant at a 5% level are fresh pork and ham. The demand for ham, with respect to sausage and wiener advertising elasticity, is significant at a 5% level. The demand for other processed pork, with respect to sausage and wiener advertising elasticity, is also significant at a 5% level. The demand for fresh pork, with respect to other processed pork advertising elasticity, is significant at a 10% level. All of the other elasticities are insignificant even at a 10% level. The majority of the cross-advertising elasticities are positive. This would suggest a complementary relationship between most of the pork products. The advertising elasticities also compare favourably to those found in Brester and Schroeder (1994) and Goddard and Griffith (1992).

Expenditure Elasticities

These values represent the change in expenditure on particular pork products due to a 1% change in expenditure on all pork products. On average, fresh pork has the highest expenditure

Table 4. Both Stages Advertising Elasticities

Elasticity of the Dependent Variables	With Respect to the Advertising Expenditure of:				
	Fresh	Ham	Bacon	Sausage	Other
Fresh	0.101 (3.39)	0.019 (1.33)	0.03 (0.61)	0.036 (0.87)	0.174 (2.00)
Ham	-0.012 (-0.49)	0.048 (4.47)	-0.026 (-0.58)	0.115 (2.64)	-0.097 (-1.24)
Bacon	0.027 (1.70)	0.011 (1.68)	0.006 (0.22)	-0.0005 (-0.02)	0.0073 (0.16)
Sausage	-0.047 (-0.93)	0.0093 (0.38)	-0.0067 (-0.07)	0.08 (1.04)	-0.238 (-1.46)
Other	0.039 (1.65)	-0.0032 (-0.29)	0.05 (1.17)	-0.205 (-4.65)	0.047 (0.59)

Note: Numbers in parentheses are the t-values for the elasticity estimates.

elasticity and sausage and wieners have the lowest expenditure elasticity. The negative value for sausage and wieners suggests that as expenditure on pork products increases, expenditure on sausage and wieners decreases. Of the five expenditure elasticities in Table 5 only the sausage and wiener elasticity is not significantly different from zero. The expenditure elasticities are larger than the elasticity reported in Brester and Schroeder (1994) for pork.

Model Simulation

Before the results from the model simulation are presented it may be helpful to explain what is happening in the Canadian and U.S. hog and pork markets by referring to Figure 2. An increase in advertising expenditure by Canadian hog producers may shift demand for Canadian pork to the right. This increase in pork demand will cause an increase in the price of pork in Canada. An increase in the price of pork will lead to an increase in the demand for hogs in Canada since the price of pork is an output price for that industry. The hog demand increase will lead to a slight hog price increase. Canada is a net exporter of hogs and pork to the U.S. Net trade with the U.S. may decrease due to the increase in demand in the Canadian market and the higher Canadian hog price. Net trade, however, depends on the relative prices in the Canadian and U.S. markets. A higher pork price will result in increased hog demand in the U.S. as well as in Canada.
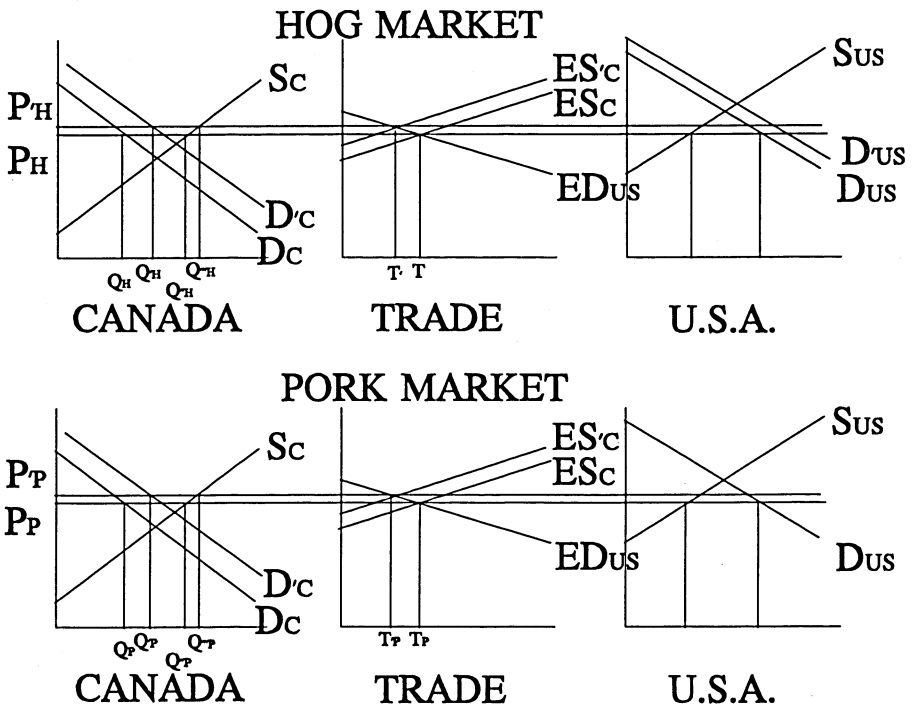
Figure 2. Impact of Increased Advertising Expenditure by Canadian Hog Producers

HOG MARKET

CANADA   TRADE   U.S.A.

PORK MARKET

CANADA   TRADE   U.S.A.

Table 5. Expenditure Elasticities

Elasticity of the Dependent Variables	With Respect to: Income
Fresh	1.76 (7.50)
Ham	0.97 (4.60)
Bacon	0.76 (5.96)
Sausage	-0.28 (-0.63)
Other	0.80 (3.50)

Note: Numbers in parentheses are the t-values for the elasticity estimates.

To simulate the effects of increased advertising of pork products in Canada the demand system was combined with behavioural equations explaining:

1.   supply of hogs in Canada
2.   demand for hogs in Canada
3.   price of hogs in Canada (linked to U.S.)
4.   price of pork in Canada (linked to U.S.)

Estimates for these equations are provided in Appendix 1. Identities were specified to endogenize net trade in hogs and net trade in pork. The complete model explained 34 endogenous variables with 9 behavioural equations and 25 identities.

The model was simulated over the period 1975-1992. The price of the other processed pork category was held exogenous in the model for ease of simulation. Base period validation statistics were considered acceptable for further simulation analysis.

The base simulation was run and then each advertising expenditure variable (generic fresh pork, branded ham, branded bacon, branded sausage and wiener, and branded other processed pork) was increased by 20% over the period 1975-1992. Five different model shocks were then performed:

•   all 5 variables were increased 20%, total additional dollar amount calculated (TADV) (Model 1)
•   "generic" fresh pork only increased by TADV (Model 2)

- "branded" ham only increased by TADV (Model 3)
- "branded" bacon only increased by TADV (Model 4)
- "branded" sausage and wiener only increased by TADV (Model 5)

The advertising expenditure increases were sustained over the time period of the simulation. Results from the base simulation and models 1-5 are presented in Tables 6 and 7.

From these simulation results incremental producer surplus from the base level was calculated for each pork category. A return on investment from advertising was then calculated for each category assuming that producers funded the additional advertising expenditure. The incremental producer surplus and return on investment are displayed in Table 8.

Table 6. Results From Exogenous Increased Advertising

Variables	Base	Model 1	Model 2	Model 3	Model 4	Model 5
Canadian Hog Price, Supply, Demand and Net Trade with U.S.						
PHG3 ($/100 kg)	158.28	158.54	158.84	159.44	158.33	158.75
SHG3 ('000)	12730	12743	12760	12761	12732	12751
HGSL2 ('000)	12234	12265	12304	12349	12240	12289
NTHOG ('000)	496	477	456	412	492	462
Annual Total Budget ($/person)						
TEXP	67.99	69.13	71.21	70.79	68.67	68.53
Expenditure Shares						
UQF	.36878	.38067	.38688	.37235	.37157	.37562
UQH	.18409	.18306	.17630	.19411	.17976	.19089
UQB	.13379	.13426	.13730	.13596	.13308	.13144
UQS	.17001	.16220	.15407	.16431	.16837	.17618
UQO	.14333	.13981	.14545	.13326	.14722	.12587

Table 7. Results From Exogenous Increased Advertising

Variables	Base	Model 1	Model 2	Model 3	Model 4	Model 5
Expenditure Share Weighted Logged Canadian Pork Price						
PSTAR	0.997	1.000	1.005	1.012	0.998	1.003
Annual Per Capita Demand (kg/person)						
DFR	12.04	12.33	12.68	13.28	12.09	12.57
DHM	3.23	3.24	3.25	3.26	3.23	3.24
DBC	2.96	2.97	2.98	2.99	2.97	2.98
DSW	3.90	3.91	3.93	3.94	3.91	3.92
DOP	3.45	3.42	3.67	3.36	3.58	3.05
Annual Per Capita Supply (kg/person)						
SUPFR	17.69	17.74	17.80	17.85	17.70	17.77
SUPHM	3.27	3.28	3.29	3.30	3.27	3.29
SUPBC	3.07	3.08	3.09	3.10	3.07	3.08
SUPSW	3.97	3.98	3.99	4.00	3.97	3.98
SUPOP	3.53	3.54	3.55	3.56	3.53	3.54
Prices ($/kg)						
PFR	2.18	2.23	2.26	2.11	2.21	2.14
PHM	3.87	3.91	3.86	4.19	3.82	4.03
PBC	3.11	3.17	3.34	3.25	3.12	3.06
PSW	2.95	2.85	2.75	2.99	2.95	3.08
Net Trade of Fresh Pork to U.S. (kg/person)						
NTFR	5.66	5.40	5.11	4.57	5.61	5.20

Note: - stocks of fresh pork are held exogenous
- POPC (price of other processed pork) is held exogenous
- FR: fresh pork, HM: ham, BC: bacon, SW: sausage and wieners
- OP: other processed pork

Table 8. Mean Additional Producer Surplus and Return On Investment from Producer Advertising

Pork Product Category	Additional Producer Surplus ('000)	Return On Investment ($)
All	$14102	11.83
Fresh Pork	$16384	13.74
Ham	$19891	16.68
Bacon	$ 1407	1.18
Sausage and Wieners	$ 4445	3.73

Note: A return on investment of $11.83 is interpreted as a return of $11.83 from an additional $1.00 investment in advertising.

- results for other processed pork were not reported because the price variable for this category is exogenous.

The large returns for all categories suggest that there is benefit to be gained from increased advertising expenditure. The best investment, according to these preliminary results for producer advertising funds, is ham. This would suggest that pork producers might be better off advertising ham or supplementing branded ham advertising done by private companies instead of advertising "generic" pork. In the past few years branded ham advertising done by private firms has decreased greatly. The next best advertising investment is fresh pork. Results also suggest positive returns occurring from bacon and sausage and wiener advertising.

Conclusion

Results from the study indicate positive returns on investment for fresh pork, ham, bacon and sausage and wiener advertising expenditure. Currently, Canadian hog producers advertise "generic" fresh pork. It may be beneficial to producers to also advertise ham products or to assist private companies with their branded ham advertising. Sausage and wiener advertising is also worth considering. However, the greatest return for producers appears to be ham advertising and fresh pork advertising.

Table 9. *Behavioural Equations*

							R^2	D-W	F-Stat

Canadian Hog Supply Equation (SHG3), 1975-1992

C	HCRAT(-2)	TIME	SHG3(-1)				R^2	D-W	F-Stat
-472602	1615400	42220.5	0.8386				.93	1.00	61.26
(-0.317)	(2.31)	(0.48)	(5.11)						
	[0.17]								

Canadian Hog Demand Equation (HGSL2), 1973-1992

C	RATIO	TIME	HGSL2(-1)						
6535580	-30689	111385	0.7555				.95	0.86	106.14
(3.88)	(-3.22)	(1.98)	(6.00)						
	[-0.39]								

Canadian Hog Price Equation (PHG3), 1974-1992

C	D9	D9B	PHG4	NTHOG	TIME	PHG3(-1)			
120.408	-87.42	0.531	0.6327	-.00001	-2.162	0.026	.91	1.47	19.21
(1.57)	(-2.01)	(1.88)	(2.37)	(-1.14)	(-.96)	(0.16)			
			[0.57]						

Canadian Pork Price Equation (PSTAR), 1973-1992

C	RPPK4	NTFR	PSTAR(-1)	TIME					
0.5657	0.1376	-.0126	0.1116	-0.0134			.98	1.53	184.997
(2.87)	(5.60)	(-3.21)	(1.03)	(-3.55)					
	[0.59]								

Note: HCRAT(-2): ratio lagged 2 periods of hog price to feed corn price
RATIO: ratio of hog price to PSTAR (weighted pork price)
D9: dummy variable (1 for 1974-1983, 0 for 1984-1992 to represent Canada's movement from almost autarky to significant exporter of hogs)
D9B: dummy variable * U.S. hog price
RPPK4: retail price of pork in U.S. (C$/kg)
NTHOG: net trade of hogs with U.S.
NTFR: net trade of fresh, frozen and chilled pork with the U.S. (kg/capita)
PHG4: U.S. hog price (C$/100 kg) adjusted for countervail duty
- numbers in round brackets are t-statistics
- numbers in square brackets are elasticities

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