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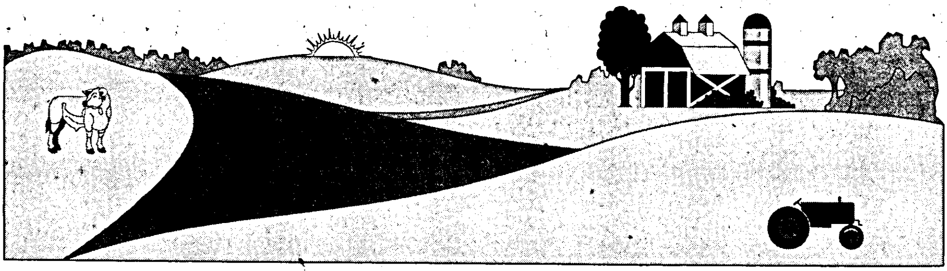

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ADVERTISING AND OLIGOPOLY POWER IN THE NORTH AMERICAN BEEF PROCESSING SECTOR

John Cranfield
Ellen Goddard

Generic advertising has become an important investment option for many farm producer organizations. Two organizations in particular are the Canadian Cattleman's Association (CCA) and the National Cattleman's Association (NCA). Both groups share a common goal of increasing beef demand (Adolf 1994; McDonell 1994). A third group interested in the same goal is the beef processing industry. Beef processors uses brand advertising to increase demand for their products and profits. In both instances, generic and brand beef advertising shift demand and raise retail price and quantity. It is this retail price change that presumably raises farm prices as well. Given the nature of cattle processing, benefits must pass through processors hands before producers realize any benefit.

Previous studies typically assume a competitive beef processing industry (Hayes and Jensen 1993; Ward and Lambert 1993; Wohlgenant 1993). However, other studies suggest that the North American beef industry is better characterized as an oligopoly and/or oligopsony (Schroeter 1988; Azzam and Pagoulatos 1990; Schroeter and Azzam 1990; Cranfield *et al.* 1995a). It has also been suggested that advertising contributes to oligopoly power by creating entry barriers (Comanor and Wilson 1974; Spence 1977; Dixit 1980; and Schmalensee 1986).

Quirmbach (1988) indicates that in the presence of oligopoly, an outward demand curve shift may not increase profits. If processor profits decrease because of advertising efforts, then farm prices may decrease or remain unchanged. Farm prices would decrease if processors bid cattle prices down in order to maintain profit margins. Thus, if processors have significant oligopoly power, higher retail prices may not manifest themselves in higher farm prices.

Free trade in beef and live cattle between Canada and the United States has existed for some time. As such, the relative size of the U.S. market, and homogeneity of inputs and outputs means beef and cattle prices in Canada are determined to a large part by U.S. prices. In addition, free trade means the structure of the U.S. market is imposed on the Canadian market. As such, oligopoly power must be considered within a North American context.

This study measures the returns from generic beef advertising given the presence of oligopoly power in the North American beef processing sector. The study is organised as follows. First, the conceptual model is presented. Next, the empirical model is illustrated. This is followed by estimation results. Then, a simulation model is used to show the impact of two generic advertising options for Canadian beef producers. Finally, a brief summary and discussion of the research results is provided.

Conceptual Model

Appelbaum (1982) provided a convenient way to measure oligopoly power. He assumed an n firm industry producing a homogenous output. It was also assumed that firms could influence output price through their production decision, but could not influence input prices (i.e. input markets are perfectly competitive). Mathematically, Appelbaum modelled the jth firm's profit maximizing output decision as: (1)

$$\mathrm{Max}_{Q^j} \{ P \cdot Q^j - C^j(Q^j, W_i) : P = P(Q,Z); Q = \sum_{j=1}^{n} Q^j \}$$

Where

P	=	output price,
Q^j	=	jth firm's output,
$C^j(.)$	=	jth firm's cost function,
W_i	=	ith input's price,
Q	=	total industry output,
$P(.)$	=	market demand curve, and
Z	=	demand factors.

A critical assumption is that the jth firm's output decision affects price. When this is accounted for, the jth firm's profit maximizing first order condition is:

$$P \cdot (1 + \frac{\theta^j}{\eta_{Q,P}}) = MC^j \tag{2}$$

Where

P	=	output price,
MC^j	=	jth firms' marginal costs,
Θ^j	=	jth firms conjectural elasticity, defined as:
$\eta_{Q,P}$	=	own price demand elasticity, defined as:

$$\eta_{Q,P} = \frac{\partial Q}{\partial P} \cdot \frac{P}{Q} \tag{3}$$

Assuming each firm possesses the same processing technology, and face the same input prices, then each firm has the same cost function. Applebaum assumes each firm also has the same constant marginal cost. This provides the condition required for linear aggregation. Linear aggregations allows for estimation of oligopoly power from industry data, rather than firm level data.

Since the first order condition is an equilibrium condition, and each firm possesses the same marginal cost, then each firm also has the same conjectural elasticity. Therefore, the industry's first order condition is:

$$P(1 + \frac{\theta}{\eta_{Q,P}}) = MC \tag{4}$$

After manipulation, the industry's first order condition can be expressed as:

$$\frac{P - MC}{P} = \frac{\theta}{\eta_{Q,P}} = LI \tag{5}$$

Where LI is the Lerner Index, and Θ and marginal cost are industry averages.

The LI measures the percentage difference between price and marginal cost. If the industry is a monopoly, then Θ=1, and the LI is equal to the inverse of the market demand elasticity. If the industry is perfectly competitive, then Θ=0, the LI is zero, and production occurs where price equals marginal cost. The industry is classified as imperfect competition if Θ falls between zero and one. In this case, the degree of oligopoly power depends on how far above marginal cost firms (or the industry) can raise the price.

Θ can be treated either parametrically, or functionally. If treated functionally, the literature is not rich as to what should be included as explanatory variables. Various studies have assumed different arguments for the conjectural equation. Table 1 shows what factors were used as explanatory variables in previous research.

Table 1. Conjectural elasticity explanatory variables

Study	Arguments
Appelbaum (1982)	Input prices
Lopez (1984)	Herfindahl Index and a time trend
Schroeter (1988)	Input prices and a time trend
Cranfield *et al.* (1955a)	Herfindahl Index, a time trend and dummy variable reflecting institutional policies in Canadian diary and poultry production
Sellen *et al.* (1955)	Brand and generic advertising, a time trend and the Herfindahl Index

The current research uses brand and generic beef advertising in Canada and the U.S. as explanatory variables in the conjectural elasticity equation. Previous research indicates that advertising may be a significant factor in the development of market power. Comanor and Wilson (1974) illustrated that firms use advertising to create entry barriers, and that entry barriers allow firms to develop market power.

Central to Comanor and Wilson's argument is the notion that advertising is a sunk cost. Over time, this sunk cost creates goodwill with consumers of the firm's product. As a result, these consumers develop inertia with respect to their purchase patterns and consumption behavior. Consequently, potential entrants must increase their advertising expenditure over that of incumbent firms. This additional expenditure is required to break consumer inertia, and gain a favorable position in the market.

Assuming, as Comanor and Wilson do, that the entrant's extra expenditure is variable with production, then the entrant faces higher per unit costs than the incumbent. Referring to the entrant's minimum average variable cost as the entry price, it is evident that incumbent firms can effect price up to the entry price without attracting new firms. However, incumbent firms will not allow price to equal or exceed the entry price, otherwise, new firms may enter the market. This pricing structure may be viewed as limit pricing since price is limited by the entry price.

In a related matter, Spence (1977) and then Dixit (1980) demonstrated that firms may deter (or at least limit) entry by using investment in plant capacity as a threat to entrants. If entry occurs (or is likely to occur), the incumbent can use capacity to increase production and lower price. If price falls below the entry price then the new firm will leave the market, or not will enter.[1] Both Spence, and Dixit indicated that advertising could be viewed in a similar vein as capacity investment, since capacity investment is assumed to be a sunk cost.

Schmalensee (1986) indicated that for advertising to be an effective entry barrier, it must be effective in thwarting entry decisions. Given the Spence-Dixit entry models, thwarting entry may only be possible if the threat of retaliation is credible. In the context of advertising, this threat may only be credible when advertising expenditure actually occurs.

On the other hand, it has been argued that firms use advertising as a means of competition. Firms may use advertising to inform consumers that they produce a product. In this light, advertising may enhance competition by allowing new firms to gain access to markets. In fact, Tesler (1964) indicated that firms may use advertising as a means of market entry.

Thus, there is no clear indication of the impact advertising has on entry barriers and oligopoly power. As such, the question of whether advertising is an entry barrier and results in oligopoly power, or is a means of market entry and contributes to competition, is an empirical question. Thus, the impact of advertising on oligopoly power should be measured by including advertising expenditures in the conjectural equation.

Confounding the impact of advertising's effect on oligopoly power in the beef industry is that two different types of beef advertising exist. Beef advertising, at the firm level, is assumed to increase demand for advertised brands. Generic beef advertising is intended to increase total beef demand. Together, generic and brand advertising may enhance or diminish market power since both may encourage incumbent firms to expand production and increase entry barriers, or may allow new firms to enter the market.

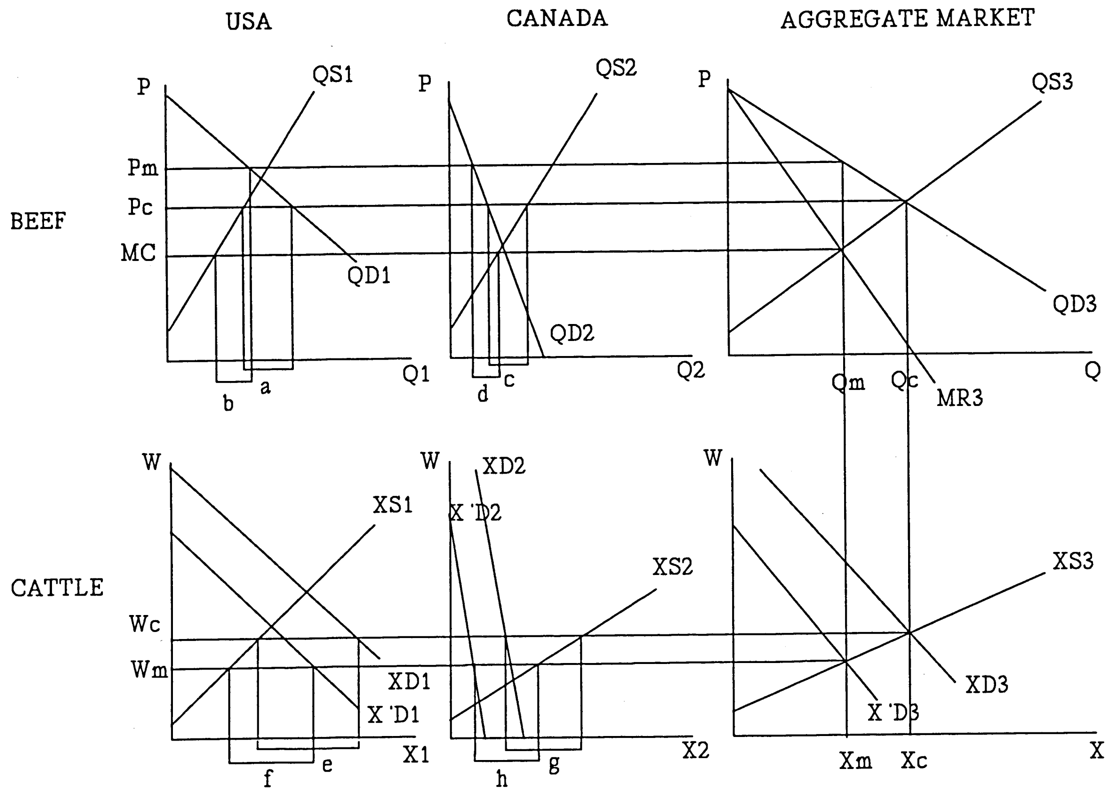
Of considerable importance to the research problem is that Canada and the U.S. have relatively free trade in homogenous inputs (live cattle) and output (beef). Following Bressler and King (1970), it is assumed that trade of homogenous goods in the presence of imperfect competition means the structure of the processing industry must be considered across regions. To determine the impact of brand and generic advertising in Canada and the U.S., a regional model is maintained. As such, it is necessary to account for the North American beef processing sector in the structure of processor input demands and the first order condition.

Since the U.S. is the larger of the two regions by a factor of about ten, it is assumed that events occurring in the U.S. result in similar occurrences in Canada. In fact, it is assumed that U.S. beef, cattle and other input prices are dominant prices in the North American market. Price linkage equations relating Canadian output and input prices to U.S. prices allow for spatial price relationships to enter into the model. Thus, the price term in the first order condition is the U.S. price. Similarly, the marginal cost term is based on U.S. input prices, while Θ and η_{QP} are the average for North American market.

Figure 1 presents a stylized version of the empirical model[2]; it shows equilibrium solutions under perfectly competitive and monopoly situations (for clarity, advertising shifts are not shown). Here Canada and the U.S. engage in free trade of vertically related commodities, namely beef and cattle.

Prices and marginal costs are determined in the aggregate North American market and then transmitted to the regional markets. Oligopoly power means price is above marginal cost, as

Figure 1. Schematic of model structure



determined by the rule $P = MC/(1+\Theta/\eta)$, where Θ is the North American conjectural elasticity and η is the demand elasticity of Q_{d3}. Quantity of beef demanded in the U.S. and Canada is determined when P intersects Q_{d1} and Q_{d2}, respectively. Similarly, the quantity of beef supplied is determined where marginal cost intersects Q_{s1} and Q_{s2}.

The price of cattle is determined where the derived demand function intersects the farm supply function in the aggregate market. Farm price is transmitted to the U.S. and Canadian cattle markets, where supply and demand are then determined. Note that the position of the derived demand curve depends on the structure of the output market. When output markets are competitive P = MC, when markets are imperfect P>MC. Therefore, the derived demand curves associated with imperfectly competitive markets lie below those of competitive markets.

Note that in oligopoly, firms' equate their perceived marginal revenue with marginal cost. The perceived marginal revenue curve lies between the true marginal revenue curve and the demand function. Consequently, the oligopoly case would have price situated somewhere between the monopoly price, P_m and the competitive price, P_c. Also note that for beef trade to clear markets, a = c and b = d. Similarly, for cattle trade e = g and f = h.

Advertising affects equilibrium in the following way. Advertising is considered a shift variable in both countries' retail beef demand curves. Investment in advertising shifts the domestic retail demand function, and the aggregate retail demand function to the right. As a result, retail price and marginal cost increase. Beef consumption increases in the country experiencing the demand curve shift, but decreases in the other country. The supply of beef in both countries increases as a result of higher marginal costs. Beef trade then adjusts to reflect the new demand and supply conditions in each region. The increase in marginal cost shifts the derived demand function right, thus raising cattle price in the aggregate market. This increases aggregate and regional cattle supply and demand. The change in cattle supply and demand effects cattle trade. These effects will hold regardless of the structure of the beef market, however, the magnitude of the effects depends on market structure.

Empirical Model

To determine the degree of oligopoly power in North American beef processing, and the impact of increased beef advertising, an econometric simulation model is employed. The complete model is derived in Cranfield (1995). The empirical model includes beef consumers, cattle processors and cattle producers in Canada and the United States. Within Canada, cattle processors and producers are split into two distinct regions--Western and Eastern Canada--to reflect differences in the nature of production and processing in these regions. In addition, cattle production is formulated to reflect fed and non-fed cattle producer decisions, and the dynamics of supply response through breeding herd inventory adjustment. The structural model can be seen in the following equations, while Table 2 provides a description of the endogenous and exogenous variables.

For brevity, the supply side of the model is not shown, but consists of slaughter steer and heifer supply, slaughter cow and bull supply, beef breeding herd inventories, feeder cattle price linkage equations and carcass weight relationships in Western and Eastern Canada and the U.S. The structural model and estimation results for the supply model can be found in Cranfield (1995).

Table 2. Endogenous and exogenous variables

Variable	Description
Endogenous variables	
PRBFj	deflated retail beef price, $/lbs, j = 3 (Canada), 4 (U.S.)
PCDBFj	per capita beef disapearance, lbs/person
DBFj	total beef disappearance, '000000 lbs
QBFi	beef production, '000000 lbs, i = 1 (Western Canada), 2 (Eastern Canada), 4 (U.S.)
CWi	carcass weight, 1/1000 lbs/head
XMi	total cattle slaughter, '000 head
PSSi	slaughter steer price, $/lbs
SSHi	steer and heifer supply, '000 head
SBWi	cow and bull supply, '000 head
PFCi	feeder calf price, $/lbs
PBWi	slaughter cow and bull price, $/lbs
IBWi	beef breeding herd inventory, '000 head
NT3BF4	net beef exports from Canada to U.S. '000000 lbs
NT1CAT4	net live cattle exports from Western Canada to U.S. '000 head
NT2CAT4	net live cattle exports from Eastern Canada to U.S. '000 head
Exogenous variables	
RPPKj	deflated retail pork price, $/lbs
RPCKj	deflated retail chicken price, $/lbs
PCDYj	deflated per capita disposable income, $/person
GBADVj	per capita deflated generic beef advertising, $/'000000 people
GPADVj	per capita deflated generic pork advertising, $/'000000 people
GCADVj	per capita deflated generic chicken advertising, $/'0000000 people
BBADVj	per capita deflated brand beef advertising, $/'0000000 people
BPADVj	per capita deflated brand pork advertising, $/'000000 people
BCADVj	per capita deflated brand chicken advertising, $/'000000 people
CPIj	all item consumer price index (1981 = 100)
ER34	Canada/U.S. exchange rate, CND$/US$
WLj	meat processing industry labour rate, $/hour
WKj	prime bank rate
IDCj	dair cow inventories, '000 head
WCNTSPF	net NTSP feeder payout in Western Canada, $/lbs
ECNTSPF	net NTSP feeder payout in Eastern Canada, $/lbs
WCNTSPS	net NTSP slaughter payout in Western Canada, $/lbs
ECNTSPS	net NTSP slaughter payout in Eastern Canada, $/lbs
FEEDSUB	Western Canadian provincial feed-grain offset payment, $/tonne
OPBA1C	Western Canada barley price, $/tonne
FCPO3	Eastern Canada corn price, $/tonne
FPC04	U.S. corn price, $/bu
NTjBF9	net beef exports to ROW, '000000 lbs
ΔSTOCKj	change in beef stocks, '000000lbs

Retail Demand

Canada: (6)

$$PCDBF3 = \alpha_1 + \beta_{11} \cdot T + \beta_{12} \cdot RPBF3 + \beta_{13} \cdot RPPK3 + \beta_{14} \cdot RPCK3 + \beta_{15} \cdot PCDY3 + \frac{\beta_{16}}{GBADV3} + \frac{\beta_{17}}{GPADV3} + \frac{\beta_{18}}{GCADV3} + \frac{\beta_{19}}{BBADV3} + \frac{\beta_{110}}{BPADV3} + \frac{\beta_{111}}{BCADV3}$$

U.S.: (7)

$$PCDBF4 = \alpha_2 + \beta_{21} \cdot RPBF4 + \beta_{22} \cdot RPPK4 + \beta_{23} \cdot RPCK4 + \beta_{24} \cdot PCDY4 + \frac{\beta_{25}}{GBADV4} + \frac{\beta_{26}}{GPADV4} + \frac{\beta_{27}}{BBADV4} + \frac{\beta_{28}}{BPADV4} + \frac{\beta_{29}}{BCADV4}$$

Price Linkage Equations

Retail price: (8)

$$RPBF3 = \alpha_3 + \beta_{31} \cdot \frac{RPBF4 \cdot CPI4 \cdot ER34}{CPI3} + \beta_{32} \cdot NT3BF4 + \beta_{33} \cdot DIQ + \beta_{34} \cdot RPBF3(-1)$$

Western Canadian farm price: (9)

$$PSS1 = \alpha_4 + \beta_{41} \cdot \frac{PSS4 \cdot CPI4 \cdot ER34}{CPI3} + \beta_{42} \cdot NT1CAT4.$$

Eastern Canadian farm price: (10)

$$PSS2 = \alpha_5 + \beta_{51} \cdot \frac{PSS4 \cdot CPI4 \cdot ER34}{CPI3} + \beta_{52} \cdot NT2CAT4$$

Labour wage rate: (11)

$$WL3 = \alpha_6 + \beta_{61} \cdot T + \beta_{62} \cdot \frac{WL4 \cdot CPI4 \cdot ER34}{CPI3}$$

Capital cost: (12)

$$WK3 = \alpha_7 + \beta_{71} \cdot T + \beta_{72} \cdot \frac{WK4 \cdot CPI4 \cdot ER34}{CPI3} + \beta_{73} \cdot WK3(-1)$$

Live cattle demand[3]
Western Canada: (13)

$$XM1 = \alpha_8 + (\beta_{81} + \beta_{82} \cdot (\frac{WL3}{PSS1})^{\frac{1}{2}} + \beta_{83} \cdot (\frac{WK3}{PSS1})^{\frac{1}{2}}) \cdot QBF1$$

Eastern Canada: (14)

$$XM2 = \alpha_9 + (\beta_{91} + \beta_{92} \cdot (\frac{WL3}{PSS2})^{\frac{1}{2}} + \beta_{93} \cdot (\frac{WK3}{PSS2})^{\frac{1}{2}}) \cdot QBF2$$

U.S.: (15)

$$XM4 = \alpha_{10} + (\beta_{101} + \beta_{102} \cdot (\frac{WL4}{PSS4})^{\frac{1}{2}} + \beta_{103} \cdot (\frac{WK4}{PSS4})^{\frac{1}{2}}) \cdot QBF4$$

The intercepts in the input demand equations were defined as: (16)

$$\alpha_i = \alpha_{i1} + \alpha_{i2} \cdot D89 + \alpha_{i3} \cdot D80$$

D89 is a dummy variable representing the Canada-U.S. Free Trade Agreement (CUSTA). This dummy variable is included to account for any changes resulting from implementation of CUSTA on January 1, 1989. D80 is a dummy variable representing structural change found to have occurred in the U.S. food processing sector (Goodwin and Brester 1995). The latter is included to reflect any effect structural change in food processing may have had on the beef processing industry.

To satisfy linear aggregation, the following restrictions were imposed on the Western and Eastern Canadian input demand parameters. Derivation of these restrictions is shown in Cranfield (1995).

Restrictions on Western Canadian input demand parameters: (17)

$$\frac{\beta_{81} = \beta_{101} \cdot \mathrm{PSS4}}{\mathrm{PSSI}}$$

$$\frac{\beta_{82} = \beta_{102} \cdot (\mathrm{WL4} \cdot \mathrm{PSS4})^{\frac{1}{2}}}{(\mathrm{WL3} \cdot \mathrm{PSS1})^{\frac{1}{2}}}$$

$$\beta_{83} = \beta_{103} \cdot \frac{(\mathrm{WK4} \cdot \mathrm{PSS4})^{\frac{1}{2}}}{(\mathrm{WK3} \cdot \mathrm{PSS1})^{\frac{1}{2}}}$$

Restrictions on Eastern Canadian input demand parameters: (18)

$$\beta_{91} = \beta_{101} \cdot \frac{PSS4}{PSS2}$$

$$\beta_{92} = \beta_{102} \cdot \frac{(WL4 \cdot PSS4)^{\frac{1}{2}}}{(WL3 \cdot PSS2)^{\frac{1}{2}}}$$

$$\beta_{93} = \beta_{103} \cdot \frac{(WK4 \cdot PSS4)^{\frac{1}{2}}}{(WK3 \cdot PSS2)^{\frac{1}{2}}}$$

First Order Condition for profit maximization: (19)

$$RPBF4\,(1 + \frac{\theta}{|\eta^{NA}_{Q,P}|}) = MC$$

North American conjectural elasticity: (20a)

$$\theta = \alpha_{11} + \frac{\beta_{111}}{(BBADV3/ER34) + BBADV4} + \frac{\beta_{112}}{(GBADV3/ER34) + GBADV4}$$

Marginal cost: (20b)

$$MC = \beta_{101} \cdot PSS4 + 2 \cdot \beta_{102} \cdot (WL4 \cdot PSS4)^{\frac{1}{2}} + 2 \cdot \beta_{103} \cdot (WK4 \cdot PSS4)^{\frac{1}{2}} + \beta_{104} \cdot WL4 + \beta_{105} \cdot WK4 + 2 \cdot \beta_{106} \cdot (WL4 \cdot WK4)^{\frac{1}{2}}$$

North American market demand elasticity: (20c)

$$\eta^{NA}_{Q,P} = (\beta_{12} \cdot \beta_{31} \cdot ER34 \cdot POP + \beta_{22} \cdot POPN4) \cdot \frac{RPBF4}{(DBF3 + DBF4)}$$

Equations 1, 2 and 3, and 6 through 20c were estimated simultaneously using the LSQ command in TSP Version 4.2B. Since the model involves non-linear equations, and cross equation constraints, LSQ is a maximum likelihood estimator. Equation 4 and 5 were estimated with OLS. To impose the spatial relationship between input prices, input price linkage equations were substituted into the appropriate Canadian price terms in the input demand equations. Supply equations were also estimated with OLS. Annual data from 1971 to 1991 was used for most equations. However, due to data limitations, some samples were reduced by one or two years.

Parameter estimates and elasticities from the retail demand/oligopoly power model are shown in Tables 3 through 7. Overall, estimation results are satisfactory. Both retail demand equations (Table 3) had the correct sign on the own-price and own-advertising coefficients. These parameter estimates were significant at 95 percent. Price linkage equations (Table 4) also fulfilled sign expectations, and most parameters were significant at 90 or 95 percent.

Input demand and the first order condition parameter estimates (Table V) had mixed results. In the input demand equations, all price coefficients were positive, and only one coefficient was not significant at 90 or 95 percent. Intercept terms on the input demand equations had mixed signs, but most were significant at 95 percent. The dummy variable for structural change was negative in the U.S. equation only, while CUSTA dummy variables were all negative and significant at 95 percent.

Parameters of the first order condition were, in general, well behaved in their signs. The parameters of the cost function satisfy concavity requirements (i.e. $\beta_{i,j}\geq 0$, $\forall i\neq j$) of the cost function. However, β_{104}, β_{105} and β_{106} were not significant at 90 or 95 percent. Parameters for the conjectural equation indicate that brand advertising in Canada and the U.S. lowers Θ, while generic advertising raises Θ. In addition, the advertising parameters in the conjectural equation were significant at 95 percent.

A complete examination of the supply model is found in Cranfield (1995). With a few exceptions, most parameters were significant and of the correct sign. Short and long run supply elasticities are shown in Table 8.

Table 6 shows oligopoly power measures at the mean. For North America, Θ equalled 0.038004. Thus, a one percent increase in the jth firms output raises industry output by .038 percent. The North American demand elasticity is reasonable given it falls between the Canadian and U.S. own price demand elasticities. The Lerner Index is .125 at the mean, suggesting that the North American beef processing industry has been able to raise price 12.5 percent above marginal cost. Θ was significantly different from zero in 6 out of 19 years (2 tailed test at 90 percent), the North American demand elasticity was significant in all years, while the Lerner Index was significantly different from zero in 10 out of 19 years.

Confidence intervals were constructed for Θ and the Lerner Index for each year. At 90 percent, the upper bound on the confidence interval for Θ was never greater than 0.09. In years when Θ was not significantly different from zero, the lower bound for the confidence interval was negative. This latter result is meaningless in the current study since Θ is bounded by zero from below. Nevertheless, the null hypothesis that Θ is significantly different from zero could not be rejected in some years but rejected in others. At the same time, the upper bound indicates that Θ is, in general, not significantly different from 0.09. Similarly, the upper bound on the confidence intervals for the Lerner Index was never greater than 0.33. Thus, during the period considered, Θ was between 0 and 0.09, while the L.I. was between 0 and 0.33.[4]

To see how advertising effects Θ, the advertising coefficient in the conjectural equation were elasticized. Table 6 shows these measures. For brand advertising, $\varepsilon_{\Theta BADV}$ (elasticity of Θ with respect to brand advertising) was negative for both Canadian and U.S. brand beef advertising, while $\varepsilon_{\Theta GADV}$ (elasticity of Θ with respect to generic advertising) was positive for both Canadian and U.S. generic beef advertising. T-tests indicate that $\varepsilon_{\Theta BADV}$ for Canada and the U.S. was significantly different from zero in only one year, whereas $\varepsilon_{\Theta GADV}$ for Canada and the U.S. was significantly different from zero in 13 out of 19 years. In general, generic advertising seems to significantly increase Θ, while brand advertising does not seem to have an effect.

Own price demand elasticities are comparable to those previously reported. For example, the following own price demand elasticises have been reported for Canada; Goddard and Griffith (1992)

Table 3. Regression results - retail beef demand

	Canada	U.S.
Estimator	ML	ML
Sample	1973 - 1991	1973-1991
Constant	144.385*	204.479*
	(52.604)	(15.878)
β_{i1}	- 5.429*	- 13.737*
	(- 101.901)	(- 5.886)
β_{i2}	- 19.832*	- 15.139*
	(- 45.789)	(- 5.467)
β_{i3}	- 12.091*	36.571*
	(- 23.233)	(10.706)
β_{i4}	- 4.506*	- .00841*
	(- 5.046)	(- 9.673)
β_{i5}	13.862*	- 33794.8*
	(51.904)	(- 28.860)
β_{i6}	- 41.907*	1805.72 †
	(- 24.054)	------
β_{i7}	- 131973 †	- 310783*
	------	(- 14.867)
β_{i8}	3.980 †	221283 †
	------	------
β_{i9}	- 1908.05*	8.38594 †
	(- 21.436)	------
β_{i10}	112735 †	

β_{i11}	115.589 †	

R^2_{adj}	.945	.885
D.W.	0.388	1.728
Log of the likelihood for multi-equation system:		-180.348

† These parameters were held constant at their OLS estimates during estimation of multi-equation system.
t-statistics are shown in parenthesis.
* Parameter significant at 95 percent.

Table 4. Regression results - Canada - U.S. price linkage equation

	RPBF3	PSS1	PSS2	WL3	WK3
Estimator	ML	OLS	OLS	OLS	OLS
Sample	1973-1991	1972-1991	1972-1991	1972-1991	1972-1991
α_i	- .262*	0.0895	.0168	5.246*	4.379
	(- 2.036)	(1.212)	(.436)	(5.633)	(1.558)
β_{i1}	1.010*	.913*	1.039*	.0523*	- .133
	(20.212)	(10.820)	(20.0138)	(2.627)	(- 1.626)
β_{i2}	- .00479*	- .000161*	- .00342*	.315*	.453*
	(- 8.625)	(- 2.398)	(- 3.528)	(4.617)	(4.708)
β_{i3}	- .204*				.274**
	(- 13.248)				(1.933)
β_{i4}	.204 †				
	(1.434)				
R^2_{adj}	0.814	.948	.962	.541	.844
D.W.	1.823	2.621	.903		
h-stat	6.297			1.236	
F-stat	176.435	239.589	12.199	35.171	

† Held constant at OLS estimates during multi-equation estimation.
* Significant at 95 percent.
** Significant at 90 percent.

-.27 to -.42 and expenditure elasticities from -.47 to -.57, ; Chen and Veeman (1991) -.77; Goddard and Chyc (1990) -.42; and Coleman and Meilke (1988) -.46. Similarly for the U.S., previously reported own price demand elasticities include; Brester and Schroeter (1994) -.49; Eales and Unneveher (1988) -.57; Moschini and Meilke (1989) -.983 (before structural change) and -1.050 (after structural change). Previously reported U.S. elasticities are large compared to the current study. One possible explanation is specification error, or alternatively that joint estimation of Canadian and U.S. retail demand affects the results.

Previously reported own advertising elasticities vary considerably for the current study. For Canada, Goddard and Griffith (1992) reported a range from -.008 to .002; while Goddard and Chyc (1990) reported .001. In the U.S., Brester and Schroeder (1994) reported a current period own advertising elasticity of .005 and a one period lagged elasticity of .009. Again specification error, and alternative modelling assumptions may play a role in these differences.

Table 5. Regression results - input demand equations and CE equation

	XM1	XM2	XM4	FOC
Estimator	ML	OLS	OLS	OLS
Sample	1973-1991	1972-1991	1972-1991	1972-1991
α_{i1}	89.286** (1.682)	110.340* (3.876)	- 1292.30 (- 1.385)	
α_{i2}	- 378.990* (- 6.904)	- 179.664* (- 6.333)	- 2631.99* (- 5.540)	
α_{i3}	129.743* (3.048)	34.734** (1.639)	- 2931.95* (- 6.562)	
β_{101}	1.137* (17.239)			
β_{102}	.0140 (0.608)			
β_{103}	.127* (11.485)			
β_{104}			- .0161 (- .281)	
β_{105}			.0267 (.923)	
β_{106}			.0177 (.488)	
α_{11}			0.259 (.993)	
β_{111}			498.958* (3.823)	
β_{112}			- 45.657* (- 4.114)	
R^2_{adj}	.818	.916	.745	.882
D.W. stat	1.903	1.846	.947	.436

* Significant at 95 percent.
** Significant at 90 percent.

Table 6. Retail demand and market power elasticities

	Canada	U.S.	North America
Retail demand elasticities with respect to quantity:			
RPBFi	- .556* (- 45.789)	- .285* (- 5.886)	- .309 ‡
RPPKi	- .307* (- 23.233)	- .236* (- 5.467)	
RPCKi	- .0665* (- 5.045)	.268* (10.706)	
PCDYi	1.447* (51.904)	- .781* (- 9.673)	
GBADVi	.0000124* (24.054)	.0114* (28.860)	
GPADVi	.0305 ‡ ------	- .00202 ‡ ------	
GCADVi	- .0000127 ‡ ------	------ ------	
BBADVi	.00362* (21.436)	.0898* (14.867)	
BPADVi	- .0162 ‡ ------	- .0352‡ ------	
BCADVi	- .000045 ‡ ------	- .227 ‡ ------	
Θ			.038004 ‡
Lerner Index			.12577‡
$\varepsilon_{\Theta GADV}$	.0372 ‡	.043 ‡	
$\varepsilon_{\Theta BADV}$	- 2.606 ‡	- .409 ‡	
Canada/U.S. retail price transmission elasticity:			
Short run	1.002 (20.212)		
Long run	1.259 ‡		

* Significant at 95 percent.
‡ t-statistic not calculated.

Table 7. Input demand elasticities

	PSSi	WLi	WKi
XM1	- .159*	.0102	0.149*
	(- 11.328)	(.608)	(11.485)
XM2	- .150*	.00959	.141*
	(- 11.328)	(.608)	(11.485)
XM4	- .188*	.0119	.176*
	(- 11.328)	(.608)	(11.485)
Canada/U.S. labour and capital price transmission elasticity:			
Labour: 0.284 ‡			
Capital:			
Short run .529 ‡			
Long run .729 ‡			

* Significant at 95 percent.
‡ t-statistic not calculated.

In terms of market power, Schroeter (1988) reported a mean Θ of .02 and mean Lerner Index of .04 for the U.S. beef packing industry. Azzam and Pagoulatos (1990) reported Θ of .223 and a Lerner Index of .460 for the U.S. meat industry, while Schroeter and Azzam (1990) reported Θ of .047 and a Lerner Index of .143. Cranfield *et al.* (1995) reported a Θ of .374 and a Lerner Index of .473 for the Canadian meat industry.

The direct effect of brand advertising is to lower Θ, while the effect of generic advertising is to raise Θ. The indirect effect (i.e. the effect through demand curve shifts changing the own price elasticity) is uncertain. To determine the total impact of advertising on oligopoly power, a simulation model is utilized. The next section addresses the impact of changing advertising levels on oligopoly power and producer revenue.

Simulation

To determine the impact of increased generic beef advertising on producer returns and oligopoly power, two policy options for Canadian beef producers are evaluated. Option one increases generic beef advertising expenditure in Canada by 20 percent. Option two contributes the 20 percent increase in the Canadian generic beef advertising expenditure to the U.S. generic beef advertising program. In both scenarios, Canadian fed-cattle producers are assumed to pay for the increase in advertising expenditure. Hence the change in their revenue will be used to measure the return. It can then be determined if Canadian beef producers are better off spending their advertising monies in a larger, price setting trade partner, or spending their budget domestically. The impact of a larger advertising budget on oligopoly power can also be determined.

Overall, the simulation results are satisfactory. Cranfield (1995) shows validation statistics for the model. However, for exposition purposes, the mean values of the actual, base and shocked endogenous variables are shown in Table 9.

Option 1

Results from increasing generic beef advertising expenditure in Canada show that the expected price/quantity changes occurred. Table 10 shows that Θ increased, and η_{QP}^{NA} became more elastic. This latter change reflects the fact that the North American own-price demand elasticity is affected through a shift in the more elastic Canadian demand curve. The impact on the Lerner Index indicates that the increase in Canadian generic beef advertising increased beef processor's Lerner Index from .12891 to .12929.

Table 11 shows that Western Canadian and U.S. producer revenue increased when the Canadian generic beef advertising expenditure was increased, but Eastern Canadian producer revenue fell. In total, Canadian producer revenue grew .012 percent, while U.S. producer revenue grew .0022 percent. The gross benefit:cost ratio to all Canadian fed cattle producers was .798:1. When the 20 percent increase in advertising expenditure is accounted for, this ratio fell to -.202:1. However, this ratio only reflects media costs, it does not reflect production costs and overhead. For pork, Duffy (1995) found that when these non-media costs were accounted for, the return to producers was about ten times smaller than with media costs only. Assuming the same relation holds in the beef industry, then the real net benefit:cost ratio is -2.02:1.

Option 2

When the 20 percent increase was given to the U.S. generic beef advertising program, the expected price/quantity changes occurred. The change in Θ was marginal, while η_{QP}^{NA} became more inelastic since the more inelastic U.S. demand curve was shifted. The Lerner Index increased to .12901.

Producer revenue in Canada and the U.S. increased with this policy option. In Canada, total fed-cattle producer revenue grew .17 percent, or C$ 2.016 million. U.S. producer revenue experienced .049 percent growth, or US$ 6.38 million. The gross benefit:cost ratio to Canadian fed-cattle producers was 10.587:1; net the increase in advertising expenditure, this ratio was 9.586:1. Adjusted for non-media costs, the net benefit:cost ratio is .9586:1.

Ward and Lambert (1993) recently found that the U.S. generic beef advertising program generated a benefit:cost ratio of about 5:1. Thus, the net benefit:cost ratio in this study is considerable smaller than Ward and Lambert's. This discrepancy may be reconciled by the fact that Ward and Lambert did not account for supply response in cattle production. Accounting for this response is vital since cattle producers will adjust production based on their expectations of future profitability. Through adjustment, producers bid additional returns into production factors. Eventually, this may increase cattle supply and reduce farm price.

Table 8. Supply, inventory and farm price linkage elasticities

	Western Canada	Eastern Canada	United States
Cow and bull inventory (short run elasticities shown above long run)			
PFCi	0.108 0.621	0.141 0.722	0.128 0.543
WKi	- 0.0899 - 0.515		
Cow and bull slaughter			
PBWi	- 0.328 - 0.467	- 0.272	- 0.313
IDBWi	1.834 0.234	0.136	2.197
Steer and heifer slaughter			
PSSi	0.431 1.879	0.191 0.579	0.0605 0.0757
FEEDi	- 0.0909 - 0.396	0.0703 0.213	- 0.0259 - 0.0324
IBWi	0.182 0.795	0.294 0.891	0.339 0.425
Carcass weight			
PSSi	0.00796 0.0135	0.0565 0.151	
FEEDi	- 0.0318 - 0.00541	- 0.0333 - 0.0889	
SSHi/SBWi	0.0911 0.155		
Feeder cattle price			
PSSi	1.584 1.824	1.642 1.645	1.545 1.763
FEEDi	- 0.382 - 0.440	- 0.409 - 0.410	- 0.484 - 0.552
Canadian farm price			
PSS4	0.931	0.998	
NTiCAT4	- 0.0609	- 0.0206	

Table 9. Endogenous variable mean values - actual, base, shocked

Variable	Actual	Base	Option 1	Option 2
RPBF3	2.506	2.352	2.362	2.341
PCDBF3	89.243	92.254	92.310	92.459
DBF3	2232.876	2313.234	2314.472	2318.566
NT3BF4	39.010	66.957	65.527	69.223
QBF1	1160.347	1186.231	1186.799	1182.799
QBF2	746.092	828.513	827.753	839.542
XM1	1942.312	1980.597	1980.420	1976.685
XM2	1250.272	1371.387	1370.336	1386.995
PSS1	0.6962	0.69256	0.69256	0.69218
PSS2	0.7396	0.7697	0.7692	0.77536
NT1CAT4	276.039	278.775	278.228	285.315
NT2CAT4	45.799	- 45.436	- 44.347	- 59.735
SSH1	1692.831	1758.447	1758.701	1760.091
SSH2	890.458	947.589	947.516	950.186
SBW1	476.343	500.925	500.947	501.908
SBW2	396.607	378.361	378.473	377.073
CW1	0.597	0.59972	0.59974	0.59942
CW2	0.597	0.60591	0.60587	0.60636
PFC1	0.8015	0.79497	0.79498	0.79403
PFC2	0.8052	0.85862	0.85776	0.86875
IBW1	3044.502	3156.356	3156.579	3157.264
IBW2	650.089	688.994	688.957	690.273
RPBF4	1.688	2.2527	2.2535	2.256
PCDBF4	107.996	107.869	107.859	108.018
DBF4	24931.667	24959.274	24927.046	24963.531
QBF4	23324.276	23293.935	23293.137	23325.926
XM4	36348.723	36410.911	36412.723	36429.879
PSS4	0.6414	0.63998	0.63988	0.6409
SSH4	28004.424	28184.318	28184.540	28201.078
SBW4	7989.936	7993.255	7994.301	8003.221
CW4	0.642	0.6437	0.6436	0.6442
PFC4	0.7718	0.7721	0.7719	0.7739
IBW4	40260.952	40741.494	40743.653	40761.360

Table 10. Base and shocked oligopoly parameters

	Actual	Base	Option 1	Option 2
Θ	0.038004	0.038004	0.038139	0.03802
η_{QP}^{NA}	- 0.30909	- 0.30751	- 0.30762	- 0.30742
Lerner Index	0.12577	0.12891	0.12929	0.12901

Table 11. Base and shocked producer revenue and returns

	Base	Option 1	Option 2
Producer revenue			
Western Canada	742.664	742.907	742.301
Absolute change		0.243	- 0.363
Percent change		0.033	- 0.049
Eastern Canada	457.970	457.879	460.349
Absolute change		- 0.091	2.379
Percent change		- 0.019	0.52
Canada	1200.634	1200.786	1202.65
Absolute change		0.152	2.016
Percent change		0.012	0.17
United States	12852.736	12853.019	12859.116
Absolute change		0.283	6.38
Percent change		0.0022	0.049
Canadian producer benefit:cost ratio			
Gross	0.798:1	10.587:1	
Net advertising	- 0.202:1	9.586:1	
Net all costs	- 2.02:1	0.9586:1	

Conclusion

This study reports empirical and simulation results for a model relating beef advertising to beef processor oligopoly power. Two relationships between advertising and oligopoly power are illustrated. In the first, advertising is shown to affect the conjectural elasticity for the North American beef packing industry. The coefficient for advertising in the conjectural equation indicates that brand advertising lowers Θ, while generic advertising raises Θ.

In addition, advertising affected oligopoly power through the own price demand elasticity. However, different effects were noticed for different options. In Canada, (the more demand elastic) an increase in advertising expenditure made North American beef demand more elastic. This lowers the Lerner Index, *ceteris paribus*. On the other hand, increasing U.S. advertising expenditure makes North American beef demand more inelastic, which increases the Lerner Index *ceteris paribus*. Taking both effects together, advertising was found to increase oligopoly power in both simulations.

In terms of producer revenue, when the increase in Canadian advertising expenditure was spent in Canada, producer revenue in Canada and the U.S. increased. However, the net benefit:cost ratio for Canadian fed-cattle producers was -2.02:1. When the increase was spent in the U.S., producer revenue in both countries also increased. In this case, the benefit:cost ratio was about 0.9586:1. These results suggest that Canadian cattlemen ought to consider spending at least some of their advertising budget in the U.S.

Finally, when the increase in advertising expenditure occurred in Canada, the Lerner Index increased by a larger magnitude than when U.S. advertising expenditure increased. From a public policy perspective, it is useful to realize that changing where advertising monies are spent can affect the degree of oligopoly power, and that this has implications regarding the level of benefits realized by producers.

Footnotes

1. This is not the exact result Dixit derived. He showed that entry may occur, but that the incumbent will use capacity investment to maintain a price leadership role in the market with the new firm.
2. This figure was taken directly from Cranfield *et at.* 1955b.
3. The underlying cost function is a linearly homogenous, quasi-homothetic Generalized Leontief:

$$C = \sum_i a_i \cdot W_i + Q \cdot \sum_i \sum_j \beta_{ij} \cdot W_i^{\frac{1}{2}} \cdot W_j^{\frac{1}{2}}$$

4. Koontz, Garcia and Hudson (1993) found that meat packers switch from cooperative to noncooperative pricing in live cattle markets (i.e. oligopsony). It may be the case that meat packers also switch in a similar manner with regards to output markets and their ability to affect beef price. In the current study, evidence suggests that there is no discernable difference between perfectly competitive price ($\Theta = 0$) and oligopolistic price ($\Theta > 0$). In this case, packers may switch from oligopoly pricing to competitive pricing depending on the relative price of live cattle to beef.

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