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ABSTRACT

To capture the potential for oligopoly power across Canadian and U.S. cattle processing sectors, a conjectural variations model is developed that incorporates trade of cattle and beef between Canada and the U.S.. The model differs from previous work since Canadian and U.S. beef processing sectors are treated as one. Moreover, the model reflects that Canada takes U.S. prices as given, but that a feed-back mechanism allows for beef and cattle trade to influence these spatial price relationships. Thus, the measure of oligopoly power is for North America and not just for Canada or the U.S. separately. In addition, brand and generic advertising in Canada and the U.S. are included as explanatory variables in the conjectural variations equation. Empirical results indicate that, North American cattle processor's conjectural elasticity averaged 0.038, while the Lerner Index averaged 0.125. Further more, generic advertising significantly increased the conjectural elasticity, while brand advertising significantly reduced the conjectural elasticity. Implications of these results are discussed.

Oligopoly Power and Advertising in the North American Beef Processing Industry

Introduction

Generic advertising has become a popular market expansion device for many farm producer organizations in North America. For instance, in an attempt to increase beef demand, both the Canadian Cattleman's Association (CCA) and the National Cattleman's Association (NCA) have spent considerable sums of money on generic advertising programs. In addition, beef processors use brand advertising to increase demand for their branded beef products. In both instances, advertising may shift demand, and possibly raise retail price and quantity. Given a competitive processing sector, this retail price change presumably raises farm prices as well. However, since the benefits resulting from generic beef advertising must pass through marketing intermediaries it is important to recognize that deviations from perfect competition may alter the benefits realized by cattle producers.

Nevertheless, previous studies evaluating generic beef advertising typically assume a competitive beef processing industry; for example Hayes and Jensen; Ward and Lambert; and Wohlgenant. However, other studies suggest that the North American beef industry is better characterized as an oligopoly and/or oligopsony; these studies include Schroeter; Azzam and Pagoulatos; Schroeter and Azzam; and Cranfield *et al.* It has also been suggested that advertising may contribute to oligopoly power by creating entry barriers; see, for instance, Comanor and Wilson; Spence; Dixit; and Schmalensee.

Also recognize that beef and live cattle trade between Canada and the U.S. may play a role in determining the degree of oligopoly power, and the payoff to advertising. Specifically, 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, relatively free trade of beef and cattle means the structure of the Canadian market reflects that of the U.S. market. As such, oligopoly power must be considered within a North American (Canada and the U.S.) context.

The purpose of this paper is to develop and estimate an empirical model that incorporates generic and brand advertising, and imperfect competition within the scope of the North American beef processing industry. The study begins with a review of the advertising and imperfect competition literature. Then, a conceptual model is developed that allows for measurement of oligopoly power in the North American beef industry, and incorporates the effect of advertising on oligopoly power, as well as on demand. Next, the empirical model is presented. This is followed by estimation results, and a brief summary and discussion of the research results is provided.

Literature Review

There have been numerous attempts made to evaluate the effect of generic and brand beef advertising on the Canadian and U.S. beef industries. Examples of studies focusing on generic advertising include Goddard and Griffith; Hayes and Jensen; Jensen and Schroeter; Ward and Lambert; and Wohlgenant to name a few. Investigations concerned with brand beef advertising effect include Funk, Meilke and Huff; and Brooker, Eastwood and Gray. Note that only Brester

and Schroeder considered the effect of brand and generic advertising at the same time. Moreover, all of the studies cited assume perfectly competitive processing and production sectors. However, there is a growing body of literature that provides ample evidence of imperfect competition in the North American beef industry.

For example, Schroeter measured oligopoly and oligopsony power in the U.S. beef packing industry, his results indicate significant oligopoly and oligopsony power in the U.S. beef packing industry. Later, Schroeter and Azzam considered the potential for oligopoly power in the U.S. meat processing (beef and pork) industry within a multi-product framework. They too found meat processors in the U.S. could exercise market power in both cattle and beef markets. Azzam and Pagoulatos had similar results, but could not statistically reject the null hypothesis of monopsony power in cattle and hog markets. For Canada, Cranfield *et al.* found that Canadian meat processors have exhibited significant oligopoly power as well.

While there have been numerous studies concerning beef advertising, and processor oligopoly power separately, there have been no efforts to integrate the relationship between advertising and oligopoly power in the Canadian or U.S. beef industries. However, there has been a significant amount of work illustrating a theorized role of advertising as an entry barrier that results in firms ability to effect output price.

In fact, previous research indicates that advertising may be a significant factor in the development of market power. Comanor and Wilson illustrated that firms use advertising to create entry

barriers, which allows them to develop market power. Central to Comanor and Wilson's argument is the notion that advertising is a sunk cost. Overtime, this sunk cost creates goodwill with consumers of the firm's product. As a result, consumers develop inertia with respect to their purchase patterns and consumption behaviour. Consequently, to break consumer inertia, and gain a favourable position in the market, potential entrants must increase their advertising expenditure over that of incumbent firms.

Assuming, as Comanor and Wilson do, that the entrant's extra expenditure is variable in production, but is a sunk cost for incumbents, then the entrant has 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 price up to the entry price without entry actually occurring. However, incumbent firms will not allow price to equal or exceed the entry price, otherwise, new firms may enter the market. In a sense, this pricing mechanism may be viewed as limit pricing since price is limited by the entry price.

In a related matter, Spence, and then Dixit 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 excess capacity to increase production and lower price. If price falls below the entry price then the new firm will leave the market, or if there is a credible threat of increased production, will not enter.[1] Both Spence, and Dixit indicated that advertising could be

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.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.

viewed in a similar vein as capacity investment since both assume capacity investment to be a sunk cost.

Schmalensee 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. As such, incumbent firm's sunk advertising cost signal potential entrants that entry may be met with an aggressive response from the incumbent.

However, both Spence and Dixit assumed quantity to be firm's strategic variable (i.e. a Cournot game). Kreps and Scheinkman illustrated the case where price is a firm's strategic variable, and quantity is a pre-committed variable. They assume a two-stage game where firms set capacity first and then compete with each other in a Bertrand price game. Their results show that this two-stage Bertrand game yields a Cournot outcome. This result is particularly important in the beef industry since this industry requires a relatively large capital pre-commitment. So even if beef packers are Bertrand oligopolists, their observed behaviour may be consistent with Cournot oligopolists.

Nevertheless, Quirmbach indicates that in the presence of oligopoly, an outward shift of the demand curve may not increase profits. If this argument is true, then where is the incentive for firms that behave in an oligopolistic manner to advertise? It is argued here that the answer is that

oligopolistic firms may use advertising as a means of limiting entry, thus sustaining presumably higher profits than under perfect competition.

On the other hand, it has also been argued that firms use advertising as a means of competition. For example, 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 indicated that firms may use advertising as a means of market entry. Thus, advertising could be viewed as possessing countervailing effects that allow for market entry, potentially driving an oligopoly to perfect competition in the limit (i.e. zero profits).

While there is no clear theoretical indication of the impact advertising has on entry barriers and oligopoly power, the above discussion illustrates how advertising could result in market power. Yet Tesler's argument shows that this hypothesis may be false. 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. In the next section, a conceptual model is developed that allows for measurement of oligopoly power, and reflects the effect of advertising on oligopoly power and demand

Conceptual Model

In this section, a conceptual model is developed that allows for measurement of oligopoly power across multiple regions engaged in free trade of homogenous inputs and outputs, and in the presence of advertising. The model is developed in stages. First, Appelbaum's conjectural

variations model is reviewed, then trade is incorporated, finally, advertising is included.

Following Appelbaum we assume an n firm industry producing a homogenous output, Q. It is also assumed that firms in the industry can influence output price through their production decisions, but can not influence input prices. Thus, an n firm, symmetric Cournot oligopoly is assumed. Mathematically, the jth firm's profit maximizing output decision is:

$$Max_{Q^j} \{P \cdot Q^j - C^j(Q^j, W_i) \mid P = P(Q, Z), Q = \sum_{j=1}^{n} Q^j\}$$

where
- P ≡ output price,
- Q^j ≡ jth firm's output,
- $C^j(\bullet)$ ≡ jth firm's cost function,
- W_i ≡ ith input's price,
- Q ≡ industry output,
- $P(\bullet)$ ≡ inverse market demand curve,
- Z ≡ demand factors.

A critical assumption is that the jth firm's output decision effects output price, but that cross firm quantity effects are zero, or $\partial Q^j/\partial Q^i=0$, $\forall i \neq j$. It is further assumed that the cost function is linearly homogenous in input prices, non-decreasing in W_i and Q, and concave and continuous in W_i. From Appelbaum, the jth firm's profit maximizing first order condition is thus stated as:

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

Where MC^j ≡ jth firm's marginal costs,
Θ^j ≡ jth firm's conjectural elasticity, defined as:

$$\theta^j = \frac{\partial Q}{\partial Q^j} \cdot \frac{Q^j}{Q}$$

$\eta_{Q,P}$ ≡ own price demand elasticity, defined as:

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

Assuming each firm has access to the same processing technologies and face the same input costs and market demand function, then each firm uses the same technology and have the same cost function. Further assuming firms have equal and constant marginal costs satisfies the condition required for linear aggregation. The benefit of linear aggregation is that it 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, after aggregating across firms, the industry's first order condition is:

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

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

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

Where *LI* is the Lerner Index, and *LI*, Θ and *MC* are industry averages.

The *LI* measures the percentage difference between price and marginal cost. If the industry is a monopoly, then $\Theta=1$, and the *LI* is equal to the inverse of the market demand elasticity. If the industry is perfectly competitive, then $\Theta=0$, the *LI* is zero, and production occurs where price equals marginal cost. The industry is classified as imperfectly competitive if $\Theta\in(0,1)$. In this case, the degree of oligopoly power depends on the price-marginal cost gap.

However, it was previously argued that since beef and cattle trade between Canada and the U.S. is relatively large, one can assume that Canadian and U.S. beef and cattle markets are in a sense one market. Thus, it is assumed that trade of homogenous goods in the presence of imperfect competition results in identical structure of both regional processing industries. However, to determine the impact of brand and generic advertising in Canada and the U.S., a regional model is maintained. Consequently, it is necessary to account for the North American beef processing sector in the structure of processors optimization problem and the resulting the first order condition.

As such, the mathematical expression of beef processor's decision changes to reflect aggregate North American demand, and regional production decisions. Thus, the jth firm's production decision is now:

$$Max_{Q^{k,j}} \{P \cdot Q^{k,j} - C^{k,j}(W_i^k, Q^{k,j}) \mid P = (Q,Z), Q = \sum_k \sum_j Q^{k,j}\}$$

where the suprascript k reflects different regions. Now, each firm's first order profit maximization condition is expressed as:

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

Assuming each firm in each region faces the same constant marginal cost again allows for linear aggregation. Thus, the multi-region first order condition can be expressed as:

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

Where Θ and MC are averages across all firms in all regions.

Now, to account for advertising effects in both regions, each firm's advertising expenditure is added to the model developed thus far. This expenditure is assumed to enter the firm's objective function as a sunk cost, and is also an element of demand. Mathematically, a firm's problem is now:

$$Max_{Q^{k,j}} \{P \cdot Q^{k,j} - C^{k,j}(W_i^k, Q^{k,j}) - ADV^{k,j} \mid$$
$$P = (Q, Z, ADV), Q = \sum_k \sum_j Q^{k,j}, ADV = \sum_k \sum_j ADV^{k,j}\}$$

Where $ADV^{k,j}$ is the jth firm's advertising in the kth region. Since advertising enters the firm's objective function as a sunk cost, it's inclusion does not directly effect the form of the first order condition. However, the impact of advertising on entry barriers and thus oligopoly power must

be accounted for in the first order condition. Here, advertising effects oligopoly power in two ways. The first is through the own price demand elasticity. When advertising induced demand shifts occur, there is presumably a change in the own price demand elasticity, thus effecting the degree of oligopoly power through the Lerner Index.

However, it is also argued that advertising effects a firm's conjectural variations. Specifically, as incumbent firms advertise more, their ability to bar entry increases. This occurs since potential entrants face a higher cost structure than incumbents. Entrants higher costs result from additional advertising expenditure required to gain market share. Moreover, it is possible that by barring entry when demand grows, the incumbent firm's ability to change total industry output increases (this results if advertising successfully shifts the demand curve out). Thus, industry output is effected by firm's output decisions, which, in turn, are related to firm's advertising decisions. Therefore, industry output is effected by firm's advertising; as such, the conjectural elasticity is also effected by advertising.

The industry conjectural variations elasticity, 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 variations equation. Table 1 shows factors included as explanatory variables in previous research.

Table 1: Factors included as explanatory variables in previous conjectural elasticity equations.

Study	Arguments
Appelbaum	Input prices
Lopez	Herfindahl Index and a time trend
Schroeter	Input prices and a time trend
Cranfield et al	Herfindahl index, a time trend and dummy variable reflecting institutional policies in Canadian dairy and poultry production.
Sellen et al	Brand and generic advertising, a time trend and Herfindahl index.

Confounding the impact of advertising's effect on oligopoly power is that two different types of beef advertising exist. Beef advertising at the firm level is assumed to increase demand for advertised brands, while 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 enable new firms to enter the market. The current research follows Sellen *et al.*, and uses Canadian and U.S. brand beef advertising and generic beef advertising as explanatory variables in the conjectural elasticity equation.

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. To reflect this, the model incorporates spatial price relationships relating Canadian prices to U.S. prices. Consequently, the price term in the first order condition is assumed to be the U.S. price. Similarly, the marginal cost term is based on U.S. input prices, but reflects the structure of the North American beef processing sector. Thus, 1 and 0_{QP} are averages for the North American

market.

Figure 1 presents a stylized version of the economic framework; it shows equilibrium solutions under perfectly competitive and monopoly situations and includes a live cattle sector (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 $P>MC$, as determined by the first order condition given previously. 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 then transmitted to the U.S. and Canadian cattle markets, where live cattle supply and demand are 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 also that 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 effects equilibrium in the following way. Since advertising is considered a shift variable in both countries retail beef demand curves, investment in advertising shifts the domestic retail demand function to the right. Consequently, the aggregate retail demand function also shifts to the right. As a result, retail price and marginal cost in the aggregate market increase. Beef consumption increases in the country experiencing the demand curve shift, but decreases in the other country. However, 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.

Empirical Model

In the previous section, it was illustrated that to measure oligopoly power in the North American beef processing sector, the first order profit maximizing condition must reflect price, marginal cost, own price demand elasticity and the conjectural elasticity for North America. Moreover, it was postulated that the effect of advertising on entry barriers, and hence the conjectural elasticity, can be captured by including advertising expenditure in the conjectural elasticity equation. In this section, an empirical model is specified that accounts for these factors. The model consists of retail beef demand equations in Canada and the U.S., price linkage equations relating Canadian

prices to those in the U.S., a North American first order condition and regional live cattle input demand equations.

A retail beef demand equation for Canada (i=1) and the U.S. (i=2) is show below.[2] A linear functional form was chosen and the usual explanatory variables were included (real beef, pork and chicken price, and real income). In addition, generic and branded beef, pork and chicken advertising variables were included in both equations. Following Venkateswaran and Kinnucan, advertising variables were included in an inverse manner to impose diminishing marginal returns from advertising. Since the U.S. had no generic chicken advertising program in the period considered, this variable was not included in the U.S. retail demand equation, nor was a time trend.

Retail beef demand:

$$PCDBFj = \alpha_i + \beta_{i1} \cdot T + \beta_{i2} \cdot RPBFj + \beta_{i3} \cdot RPPKj + \beta_{i4} \cdot RPCKj + \beta_{i5} \cdot PCDYj + \frac{\beta_{i6}}{GBADVj} + \frac{\beta_{i7}}{GPADVj} + \frac{\beta_{i8}}{GCADVj} + \frac{\beta_{i9}}{BBADVj} + \frac{\beta_{i10}}{BPADVj} + \frac{\beta_{i11}}{BCADVj} \quad (1)$$

To reflect U.S. price taking behaviour in the Canadian beef market, real Canadian beef prices are specified as a function of real U.S. beef price (in Canadian dollars), net beef exports from Canada to the U.S., an import quota dummy variable and a lagged dependent variable. This price linkage

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.Data definitions and sources may be found in Appendix 2.

equation is shown below. This type of relationship has been used in several other spatial models, for example Coleman and Meilke. Net beef exports are included to reflect different price relationships as trade volume changes. The import quota dummy variable is included to account for the effect of trans-shipments of offshore beef through Canada when the U.S. imposed import quotas on Australian and New Zealand.

Canada-U.S. retail beef price linkage:

$$RPBF3 = \alpha_3 + \beta_{31} \cdot \frac{RPBF4 \cdot CPI4 \cdot ER34}{CPI3} + \beta_{32} \cdot NT3BF4 + \beta_{33} \cdot DIQ + \beta_{34} \cdot RPBF3(-1) \quad (3)$$

To aid estimation of oligopoly power, beef processor live cattle input demand equations are also estimated. This imposes considerable structure on the model, and helps to identify the marginal cost component of the first order condition. These input demand equations are derived by applying Shephard's Lemma to an underlying cost function. This study assumes processor's technology is a fixed proportions technology and satisfies the conditions required for linear aggregation. As such, a Gorman form Generalized Leontief (GL) cost function is assumed:

$$C = \sum_i \alpha_i \cdot W_i + \sum_i \sum_j \beta_{i,j} \cdot W_i^{0.5} \cdot W_j^{0.5} \cdot Q$$

This cost function is quasi-homothetic and linearly homogenous in input prices. The corresponding *regional* live cattle input demand equations are shown below.

Western Canada live cattle demand:

$$XM1 = \alpha_4 + \left(\beta_{41} + \beta_{42} \cdot \left(\frac{WL3}{PSS1} \right)^{0.5} + \beta_{43} \cdot \left(\frac{WK3}{PSS1} \right)^{0.5} \right) \cdot QBF1 \qquad (4)$$

Eastern Canada live cattle demand:

$$XM2 = \alpha_5 + \left(\beta_{51} + \beta_{52} \cdot \left(\frac{WL3}{PSS2} \right)^{0.5} + \beta_{53} \cdot \left(\frac{WK3}{PSS2} \right)^{0.5} \right) \cdot QBF2 \qquad (5)$$

U.S. live cattle demand:

$$XM4 = \alpha_6 + \left(\beta_{61} + \beta_{62} \cdot \left(\frac{WL4}{PSS4} \right)^{0.5} + \beta_{63} \cdot \left(\frac{WK4}{PSS4} \right)^{0.5} \right) \cdot QBF4 \qquad (6)$$

The intercepts in the input demand equations are defined as:

$$\alpha_i = \alpha_{i1} + \alpha_{i2} \cdot D89 + \alpha_{i3} \cdot D80 \qquad i = 4,5,6$$

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). The latter is included to reflect any effect structural change in the food processing industry may have had on the beef processing industry.

Since the first order condition for North America has a marginal cost component for all North America, the input demand equations must reflect this; as such, restrictions are placed on the parameters of the Western and Eastern Canadian input demand equations. These restrictions are shown below, and are derived in Appendix 1. Imposing these restrictions allows for linear aggregation of cost functions across regions, thus allowing for estimation from industry data that is available for Canada and the U.S.. Restrictions on regional input demand parameters are as follows:

$$\beta_{i1} = \beta_{61} \cdot \frac{PSS4}{PSSj}$$

$$\beta_{i2} = \beta_{62} \cdot \left(\frac{WL4 \cdot PSS4}{WL3 \cdot PSSj} \right)^{0.5} \qquad (i,j)=(4,1),(5,2)$$

$$\beta_{i3} = \beta_{63} \cdot \left(\frac{WK4 \cdot PSS4}{WK3 \cdot PSSj} \right)^{0.5}$$

To relate the remaining regional price relationships, price linkage equations are substituted into these restrictions during estimation. The remaining price linkage equations are presented below. Western and Eastern Canadian farm prices are related to U.S. farm prices and net live cattle exports from Western, and Eastern Canada to the U.S..

Western Canadian farm price linkage:

$$PSS1 = \alpha_7 + \beta_{71} \cdot \frac{PSS4 \cdot CPI4 \cdot ER34}{CPI3} + \beta_{72} \cdot NT1CAT4 \qquad (7)$$

Eastern Canadian farm price linkage:

$$PSS2 = \alpha_8 + \beta_{81} \cdot \frac{PSS4 \cdot CPI4 \cdot ER34}{CPI3} + \beta_{82} \cdot NT2CAT4 \qquad (8)$$

To add further structure to the model, Canadian labour and capital costs are related to those in the U.S.. These relationships are included to allow for linear aggregation across North America, and are not intended to indicate a causal relationship.

Labour wage rate linkage:

$$WL3 = \alpha_9 + \beta_{91} \cdot T + \beta_{92} \cdot \frac{WL4 \cdot CPI4 \cdot ER34}{CPI3} \qquad (9)$$

Capital cost linkage:

$$WK3 = \alpha_1 + \beta_{101} \cdot T + \beta_{102} \cdot \frac{WK4 \cdot CPI4 \cdot ER34}{CPI3} + \beta_{103} \cdot WK3(-1) \qquad (10)$$

To complete the empirical model, the first order condition for the North American beef processing industry is specified below. Recall that the U.S. beef price is assumed to be the dominate North American price and that MC, θ and η are for North America.

First order profit maximization condition:

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

Where Θ is specified as:

Where Θ is specified as:

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

Marginal cost, as derived from the North American cost function, is expressed as:

$$MC = \beta_{101} \cdot PSS4 + 2 \cdot \beta_{102} \cdot (WL4 \cdot PSS4)^{0.5} + 2 \cdot \beta_{103} \cdot (WK4 \cdot PSS4)^{0.5} + \beta_{104} \cdot WL4 + \beta_{105} \cdot WK4 + 2 \cdot \beta_{106} \cdot (WK4 \cdot WL4)^{0.5} \tag{11b}$$

Since the North American markets are treated as one, the North American own price demand elasticity is defined from parameters in the individual retail demand equations, and the Canada-U.S. retail price linkage equation, and is defined as:

$$\eta_{Q,P}^{NA} = (\beta_{12} \cdot \beta 31 \cdot ER34 \cdot POP + \beta_{22} \cdot POPN4) \cdot \frac{RPBF4}{(DBF3 + DBF4)} \tag{11c}$$

Equations 11a, 11b and 11c were substituted into the first order condition during estimation.

In this section, an empirical model was developed that enables measurement of oligopoly power in the North American beef processing industry. This model incorporates the effect of brand and generic advertising on retail demand, and the hypothesized effect on oligopoly power. Next, results for the specified model are presented. Elasticities, measures of oligopoly power and the measured effect of advertising on oligopoly power will also be presented.

Results

For the period 1973 to 1991, equations 1 through 6 and 11 (a, b and c) were estimated simultaneously using the LSQ command in TSP Version 4.2B. Since the model has non-linear equations with cross equation restrictions, LSQ is a maximum likelihood estimator. To impose the spatial relationship between input prices, equation 7, 8, 9, and 10 were estimated with OLS and substituted into the appropriate Canadian price terms in the input demand equations during estimation of the system.

Parameter estimates and elasticities from the retail demand/oligopoly power model are shown in Tables 2 through 8. Overall, estimation results are satisfactory. Both retail demand equations (Table 2) had theoretically consistent signs on the own price and own advertising co-efficients. In addition, these parameters were significant at 95 percent and both equations had high adjusted R^2.

Estimates of the parameters in most price linkage equations (Table 3) fulfilled sign expectations, and most parameters were significant at 90 or 95 percent. With the exception of the wage linkage equation, all price linkage equations had high R^2. With the exception of the WL3 and WK3 equations, there was no or little auto-correlation measured in the price linkage equations.

Input demand and the first order condition parameter estimates (Table 4) had mixed results. In the input demand equations, all price co-efficients were positive, and only one co-efficient was not significant at 90 or 95 percent. Intercept terms in the input demand equations had mixed signs, but most were significant at 95 percent. The dummy variable for structural change (D80) was

negative in the U.S. equation only, while the CUSTA dummy variables were all negative and significant at 95 percent. The latter results suggests that the CUSTA agreement may have contributed to a decline in slaughter demand.

Parameters for the first order condition were generally well behaved in their signs. The parameters of marginal cost satisfy concavity requirements (i.e. $\beta_{ij} \geq 0$, $\forall i \neq j$) of the cost function. However, β_{104}, β_{105} and β_{106} were not significantly different from zero at 90 or 95 percent. Parameters in the conjectural variation equation indicate that brand advertising in Canada and the U.S. lowers Θ, while generic advertising raises Θ. In addition, both advertising parameters in the conjectural equation were significant at 95 percent. Overall, the input demand - first order condition group had a good fit, and with the exception of the U.S. live cattle demand and first order condition, no auto-correlation was detected.

Table 5 shows the mean values of price, income and advertising elasticities, and measures of oligopoly power. Table 6 shows input demand and price transmission elasticities at the mean. For beef, the own price demand elasticities are comparable to those previously reported (see Table 7). However, 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 effects the magnitude of the elasticities. As well, this study's own advertising elasticities vary considerably from those previously reported. Again specification error, and alternative modelling assumptions may play a role in these differences.

For North America, Θ equalled 0.038 on average from 1973 to 1991. Thus, a one percent increase in the jth firm's output raises industry output by .038 percent, on average. The North American demand elasticity fell between the Canadian and U.S. own price demand elasticities, as expected. The Lerner Index was .125 at the mean, suggesting that the North American beef processing industry has been able to raise price 12.5 percent above marginal cost on average for the sample. These results are somewhat similar to previous efforts to measure oligopoly power (see Table 7).

Confidence intervals were constructed for Θ and the Lerner Index for each year (Table 8). Θ was significantly different from zero in 5 out of 19 years (2 tailed test at 90 percent signifigance), while the Lerner Index was significantly different from zero in 10 out of 19 years. At 90 percent, the upper bound on the confidence interval for Θ was never greater than 0.09. Similarly, the upper bound on the confidence intervals for the Lerner Index was never greater than 0.33. One way to interpret this, is that during the period considered, Θ varied between 0 and 0.09, while the Lerner Index varied between 0 and 0.33.

There are a number of explanations as to the range of Θ. First, Koontz, Garcia and Hudson found that meat packers switch from cooperative to noncooperative pricing in live cattle markets (i.e. oligopsony). It may also be the case that meat packers also switch in a similar manner with regards to output markets and their ability to effect beef price. Evidence presented here would suggest that in some years there is no discernable difference between perfectly competitive pricing (Θ=0) and oligopolistic pricing (Θ>0). In this case, packers may switch from oligopoly pricing to

competitive pricing depending on the relative price of live cattle to beef and anticipated future live cattle supply.

An alternative explanation is that production inefficiencies result in a price marginal cost gap that appears as oligopoly power. Here output price would equal marginal cost of inputs plus a cost inefficiency term. Given the relatively small deviation from perfectly competitive pricing over the sample, this argument seems just as compelling as the previous.

An important result is the effect of brand and generic advertising on the conjectural elasticity. The parameters of the generic advertising parameter in the conjectural equation indicate that generic advertising has a positive and significant effect on Θ. In contrast, the parameter on brand advertising illustrates that brand advertising reduces the value of Θ. All things being equal, these parameters suggest that generic advertising increases oligopoly power, while brand advertising decreases oligopoly power. Note, however, that the model assumes equal effects of Canadian and U.S. brand and generic advertising on Θ.

The effects of generic and brand advertising on Θ are puzzling to say the least. However, one plausible explanation for these effects is that generic advertising tends to result in market growth, while brand advertising allows firms to fight amongst themselves for larger market share of a growing market. Consequently, firms in the industry gain larger market shares, but as a result of generic advertising, not necessarily their own advertising.

An equally like scenario is that the generic and brand advertising decisions occur within a two-stage repeated game. In this instance, the level of generic advertising is determined in the first stage, and then the level of brand advertising in the second. With this structure, firms optimal choice of brand advertising depends on the level of generic advertising. Consequently, optimal behaviour might be to adopt a lower level of brand advertising, and free-ride on generic advertising. Thus, the differing effect of generic and brand advertising may be a result of the structure of the game, whereby generic advertising enables firms to develop market power.

Conclusions

The objective of this study was to develop and estimate a model that measures oligopoly power across multiple regions and incorporates advertising. To this end, it was illustrated that Appelbaum's conjectural variation model can be extended to a multiple region model. Moreover, the effect of advertising on oligopoly power can be captured through the first order profit maximizing condition.

An empirical example of this approach was presented; in it, North American beef processor's oligopoly power was measured and the impact of advertising on their market power determined. It was shown that simultaneous estimation across two regions that engage in free trade resulted in oligopoly measures somewhat consistent with previous work. The effect of advertising on oligopoly power was mixed, with generic advertising shown to contribute to oligopoly power, while brand advertising reduced oligopoly power.

While the results concerning oligopoly power seem indicative of past research efforts, the effect of advertising on oligopoly power is perplexing. The effect of brand advertising on oligopoly power suggests that processing firms use it as a countervailing tool against their competitors and potential entrants. However, the positive relationship between generic advertising and oligopoly power suggests that the rational for publicly mandated generic advertising programs that contributes to a Pareto inferior outcome is possibly one sided.

However, this latter result points to an area of further research. Specifically, many of the studies cited at the beginning of this paper set out to measure the benefits generated by generic advertising in a perfectly competitive environment. Given the results of this study, it seems important to incorporate the potential for imperfect competition in evaluating these programs. Moreover, from a public policy point of view, weighing the costs of an advertising program against the benefits must reflect the deadweight loss of imperfect competition; otherwise, any quantitative results are meaningless.

Further areas of research include extending the model developed here to reflect input and output heterogeneity, the effect of advertising on product differentiation across regions, incorporation of oligopsony power, and development of a dynamic market power framework for the North American beef processing industry.

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Appendix 1- Derivation of Input Demand Function Parameter Restrictions

In this Appendix, the restrictions placed on the parameters of the cost functions for Western and Eastern Canada are derived. First, it is assumed that all firms have access to the same technology, and that all firms face the same factor prices and market demand curve. In addition, it is assumed that Canadian factor prices are related to those in the U.S. according to the following relationships:

$$W_{l,WC} = \gamma_{l,WC} + \delta_{l,WC} \cdot W_{l,US}$$

$$W_{l,EC} = \gamma_{l,EC} + \delta_{l,EC} \cdot W_{l,US}$$

Defining the regional cost functions as:

$$C^k = \sum_i \alpha_{k,i} \cdot W_{i,k} + \sum_i \sum_j \beta_{k,i,j} \cdot W_{i,k}^{0.5} \cdot W_{j,k}^{0.5} \cdot Q^k$$

where *k* denotes the region. Substituting the appropriate price linkage equation into the Western and Eastern Canadian cost functions, and summing over all three regions yields:

$$C^{NA} = \sum_l \alpha_{4,l} \cdot (\gamma_{WC,l} + \delta_{WC,l} \cdot W_{US,l}) +$$

$$Q^{WC} \cdot \sum_l \sum_m \beta_{4,l,m} \cdot (\gamma_{WC,l} + \delta_{WC,l} \cdot W_{US,l})^{0.5} \cdot (\gamma_{WC,m} + \delta_{WC,m} \cdot W_{US,m})^{0.5} +$$

$$\sum_l \alpha_{5,l} \cdot (\gamma_{EC,l} + \delta_{EC,l} \cdot W_{US,l}) +$$

$$Q^{EC} \cdot \sum_l \sum_m \beta_{5,l,m} \cdot (\gamma_{EC,l} + \delta_{EC,l} \cdot W_{US,l})^{0.5} \cdot (\gamma_{EC,m} + \delta_{EC,m} \cdot W_{US,m})^{0.5} +$$

$$\sum_l \alpha_{6,l} + Q^{US} \cdot \sum_l \sum_m \beta_{6,l,m} \cdot W_{US,l}^{0.5} \cdot W_{US,m}^{0.5}$$

Assuming the equilibrium condition $P(1+\Theta/\eta)=MC$ holds across North America, then regional marginal costs must be the same. Because the U.S. is assumed to be the price 'maker', the marginal cost for Western and Eastern Canada are to be equated to that in the U.S.. One way to equate marginal costs is to impose the following :

$$\beta_{4,l,m} \cdot (\gamma_{WC,l} + \delta_{WC,l} \cdot W_{US,l})^{0.5} \cdot (\gamma_{WC,m} + \delta_{WC,m} \cdot W_{US,m})^{0.5} =$$

$$\beta_{6,l,m} \cdot W_{US,l}^{0.5} \cdot W_{US,m}^{0.5} \quad \forall \ (l,m)$$

$$\beta_{5,l,m} \cdot (\gamma_{EC,l} + \delta_{EC,l} \cdot W_{US,l})^{0.5} \cdot (\gamma_{EC,m} + \delta_{EC,m} \cdot W_{US,m})^{0.5} =$$

$$\beta_{6,l,m} \cdot W_{US,l}^{0.5} \cdot W_{US,m}^{0.5} \quad \forall \ (l,m)$$

Which implies:

$$\beta_{4,l,m} = \beta_{6,l,m} \cdot \frac{W_{US,l}^{0.5} \cdot W_{US,m}^{0.5}}{(\gamma_{WC,l} + \delta_{WC,l} \cdot W_{US,l})^{0.5} \cdot (\gamma_{WC,m} + \delta_{WC,m} \cdot W_{US,m})^{0.5}} \quad \forall \ (l,m)$$

$$\beta_{5,l,m} = \beta_{6,l,m} \cdot \frac{W_{US,l}^{0.5} \cdot W_{US,m}^{0.5}}{(\gamma_{EC,l} + \delta_{EC,l} \cdot W_{US,l})^{0.5} \cdot (\gamma_{EC,m} + \delta_{EC,m} \cdot W_{US,m})^{0.5}} \quad \forall \ (l,m)$$

Substituting these into the North American cost function, factoring and substituting out for Canadian prices yields:

$$C^{NA} = \sum_k \sum_l \alpha_{k,l} \cdot W_{l,k} + (Q^{WC} + Q^{EC} + Q^{US}) \cdot \sum_l \sum_m \beta_{6,l,m} \cdot W_{US,l}^{0.5} \cdot W_{US,m}^{0.5}$$

From this, the North American marginal cost can be calculated by differntating with respect to $(Q^{WC}+Q^{EC}+Q^{US})$.

Appendix 2 - Data Definition and Sources

Variable names used in the empirical model and sources of these data are given in this Appendix. Endogenous and exogenous variables are defined below, the j index represents Canada (j=3) or the U.S. (j=1), while i represents Western Canada (i=1), Eastern Canada (i=2) and the U.S. (i=4). All prices, income and advertising expenditure variables were deflated by the all item CPI for the respective countries. Unless other wise stated, all variables were included in the domestic currency.

PCDBFj - per capita beef disappearance; lbs/person; Agriculture Canada Farmbank,

RPBFj - deflated retail beef price; $/lbs; Agriculture Canada Farmbank;

RPPKj - deflated retail pork price; $/lbs; Agriculture Canada Farmbank,

RPCKj - deflated retail chicken price; $/lbs; Agriculture Canada Farmbank,

PCDYj - deflated per capita disposable income; $/person; Agriculture Canada Farmbank,

GBADVj - deflated per capita generic beef expenditure; $/000,000 people,

GPADVj - deflated per capita generic pork expenditure; $/000,000 people,

GCADV3 - deflated per capita generic chicken expenditure in Canada; $/000,000 people,

BBADVj - deflated per capita brand beef expenditure; $/000,000 people,

BPADVj - deflated per capita brand pork expenditure; $/000,000 people,

BCADVj - deflated per capita brand chicken expenditure; $/000,000 people,

ER34 - Canada/U.S. exchange rate; C$/US$; Agriculture Canada Farmbank,

NT3BF4 - net beef exports from Canada to the U.S.; `000,000 lbs; Agriculture Canada, Farmbank,

CPIj - all item consumer price index; 1981=100; Agriculture Canada Farmbank,

PSSi - deflated slaughter steer price; $/lbs; Western Canada price is for A1,2 slaughter steers (1050 lbs) in Calgary, Eastern Canada is for A1,2 slaughter steers (1050 lbs) in Toronto, U.S. price is Choice slaughter steers (900-1100 pounds) in Omaha; Agriculture Canada Farmbank;

NT1CAT4 - net live cattle exports from Western Canada to the U.S.; '000 head; derived by subtracting fed and mature cattle imports from adding up fed and mature cattle exports for Western Canada; Agriculture Canada Farmbank,

NT2CAT4 - net live cattle exports from Eastern Canada to the U.S.; '000 head; derived by subtracting fed and mature cattle imports from adding up fed and mature cattle exports for Western Canada; Agriculture Canada Farmbank,

WLj - deflated labour rate for the respective meat packing industries; $/hour; derived by dividing total production worker wage bill by total production hours worked; Statistics Canada 31-203, 32-232, and 32-221, and U.S. Department of Commerce, Census of Manufactures, Industry #2011 Meat Packing Plants,

WKj - prime bank rate; %; Bank of Canada Monthly Review and CANSIM,

XMi - total cattle slaughter; '000 head; the sum of steer, heifer, cow and bull disappearance; Agriculture Canada Farmbank,

QBF1 - beef production in Western Canada; `000,000 lbs; derived by multiplying carcass weight by total cattle slaughter in Western Canada,

QBF2 - beef production in Eastern Canada; `000,000 lbs; derived by multiplying carcass

weight by total cattle slaughter in Eastern Canada,

QBF4 - beef production in the U.S.; `000,000 lbs; Agriculture Canada,

POP - Canadian population; `000,000 people; Agriculture Canada Farmbank,

POPN4 - U.S. population; `000,000 people; Agriculture Canada Farmbank,

Figure 1. Schematic of model structure

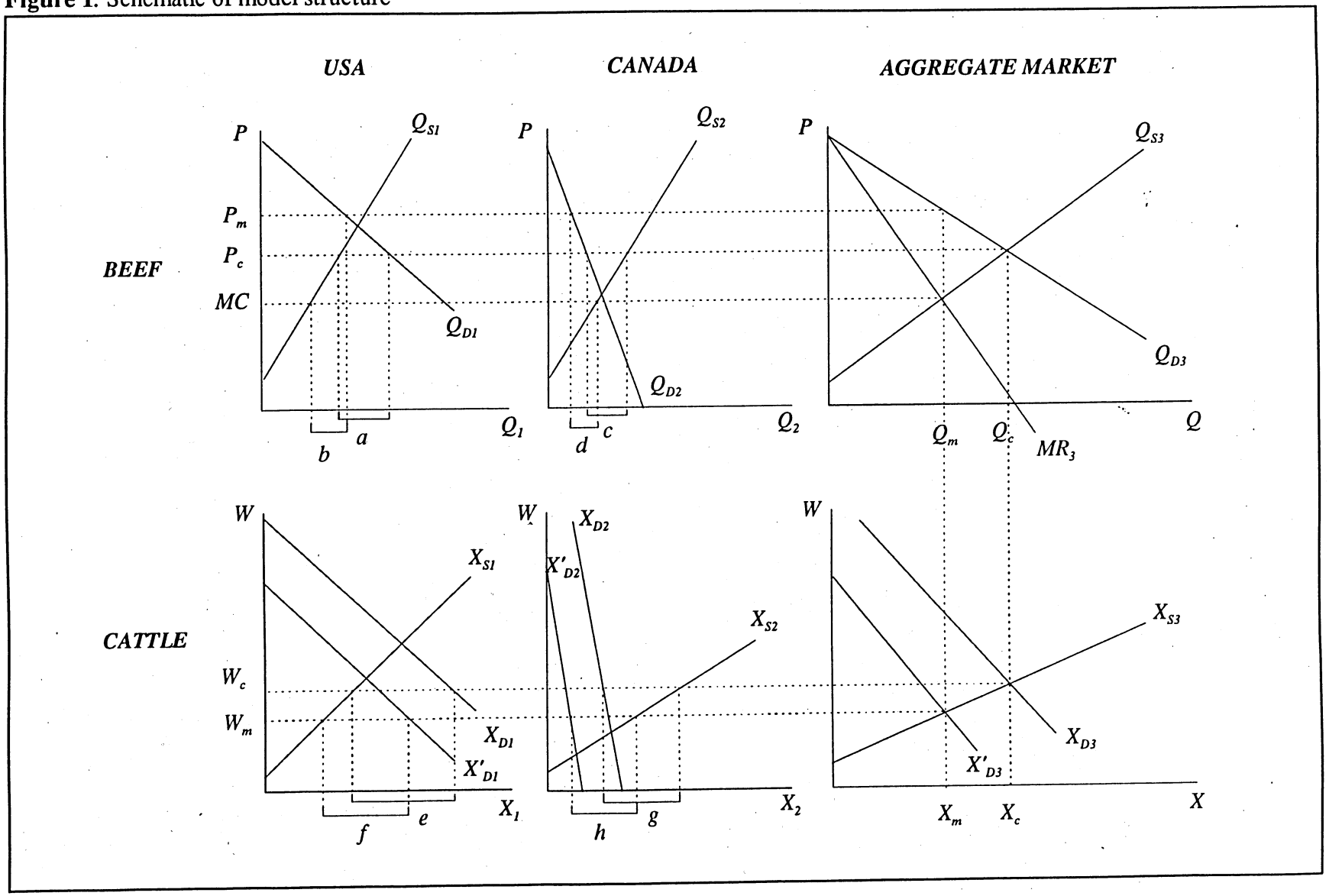

Table 2: Retail demand estimation results.

	Canada	U.S.
α_i	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 *	838594 †
	(-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 3: Price linkage estimation results.

	RPBF3	PSS1	PSS2	WL3	WK3
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 *	-.000342 *	.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 estimate during multi-equation estimation.
* Significant at 95 percent
** Significant at 90 percent

Table 4: Input demand, first order condition estimation results.

	XM1	XM2	XM4	FOC
α_{i1}	89.286 **	110.340 *	-1292.30	
	(1.682)	(3.876)	(-1.385)	
α_{i2}	-378.990 *	-179.664 *	-2631.99 *	
	(-6.904)	(-6.333)	(-5.540)	
α_{i3}	129.743 *	34.734 **	-2931.95 *	
	(3.048)	(1.639)	(-6.562)	
β_{101}			1.137 *	
			(17.239)	
β_{102}			.0104	
			(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 5: Price, income and advertising elasticities, and oligopoly power measures (mean values).

	Price and Income		Generic Advertising		Brand Advertising	
	Canada	U.S.	Canada	U.S.	Canada	U.S.
RPBFi	-.556*	-.285*	.0000124 *	.0114 *	.00362*	.0898*
	(-45.789)	(-5.886)	(24.054)	(28.860)	(21.436)	(14.867)
RPPKi	-.307*	-.236*	0305‡	-.00202‡	-.0162‡	-.0352‡
	(-23.233)	(-5.467)	---------	---------	---------	---------
RPCKi	-.0665*	.268*	-.0000127‡	---------	-.000045‡	-.227‡
	(-5.045)	(10.706)	---------	---------	---------	---------
PCDYi	1.447*	-.781*				
	(51.904)	(-9.673)				

Oligopoly measures:

	North America
Θ	.038 ‡
Lerner Index	.125 ‡
Demand Elasticity	-.309 ‡

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

Table 6: Input demand and price transmission elasticities (mean values).

	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)

Price transmission elasticities:

	Retail	Labour	Capital	PSS1	PSS2
Short run	1.002 ‡	0.284 ‡	.529 ‡	.931 ‡	.914 ‡
Long run	1.259 ‡		.729 ‡		

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

Table 7: Previously estimated elasticities, and oligopoly power measures.

	Canada	U.S.
Own price:		
Goddard and Griffith (1992)	-0.27 to -0.42	
Chen and Veeman (1991)	-0.77	
Goddard and Chyc (1990)	-0.42	
Coleman and Meilke (1988)	-0.46	
Brester and Schroeder (1994)		-0.49
Eales and Unneveher (1988)		-0.57
Moschini and Meilke (1989)		-0.983 and -1.050
Income/Expenditure		
Goddard and Griffith (1992)	-0.47 to -0.57	
Moschini and Meilke (1989)		1.22 to 1.394
Advertising		
Goddard and Griffith (1992)	-0.008 to 0.002	
Goddard and Chyc (1990)	0.001	
Brester and Schroeder (1994)		0.005 (current period) 0.009 (one period lag)
Conjectural Elasticities		
Schroeder (1988)		0.02
Azzam and Pagoulatos (1990)		0.223
Schroeter and Azzam (1990)		0.047
Cranfield *et al.* (1995)	0.374	
Lerner Index		
Schroeder (1988)		0.04
Azzam and Pagoulatos (1990)		0.460
Schroter and Azzam (1990)		0.143
Cranfield *et al.* (1995)	0.473	

Table 8: Conjectural elasticity, Lerner Index and confidence intervals.

Year	Θ			Lerner Index		
	Value	Lower Bound	Upper Bound	Value	Lower Bound	Upper Bound
1973	0.029	-0.003	0.061	0.077	-0.001	0.156
1974	0.032	-0.001	0.065	0.099	0.007	0.192
1975	0.035	0.001	0.069	0.116	0.014	0.218
1976	0.054	0.017	0.091	0.212	0.092	0.333
1977	0.036	-0.002	0.074	0.144	0.002	0.285
1978	0.036	-0.002	0.075	0.115	0.004	0.226
1979	0.033	-.006	0.071	0.080	-0.008	0.168
1980	0.033	-0.004	0.069	0.087	-0.003	0.177
1981	0.038	-0.003	0.078	0.111	0.001	0.219
1982	0.047	-0.008	0.087	0.144	0.037	0.252
1983	0.046	0.006	0.086	0.151	0.035	0.268
1984	0.056	0.017	0.095	0.183	0.076	0.290
1985	0.049	0.009	0.088	0.173	0.048	0.297
1986	0.036	-0.005	0.077	0.132	-0.010	0.275
1987	0.033	-0.008	0.075	0.119	-0.020	0.258
1988	0.032	-0.009	0.075	0.116	-0.023	0.256
1989	0.034	-0.007	0.076	0.115	-0.016	0.247
1990	0.031	-0.011	0.073	0.105	-0.028	0.237
1991	0.032	-0.009	0.074	0.109	-0.025	0.242