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Pricing Games in Poultry Markets: The Cases of Eggs in Australia and Chicken in Canada

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Abstract

Given the increasing concentration in numerous markets recent interest in market structure and performance has grown dramatically. The empirical research revolves around theories of industrial organization and non-cooperative game theory. Research in this area uses participant strategic action not only to define market structure but also participant conduct. In the Australian egg market and Canadian fresh chicken market we reject the more competitive assumption of Bertrand-Nash behavior in favor of Stackelberg/leader-follower relationships. In Australia Pace Farms emerges as the industry leader while in Canada generic product overwhelmingly controls the market.

Introduction

In the Australian egg market, Canadian chicken market, and various other markets throughout the world increasing concentration in processing and retailing is becoming a noticeable trend. In Australia processor numbers have decreased form 566 in 1994 to 508 in 2000. In contrast gross value of production and volume of production has increased from $233.9 million (174,053,000 dozen) to $321.4 million (182,179,000 dozen) (Department of Agriculture, 2002). In Canada as of 1998 the five largest processing companies accounted for 58% of the poultry processed in Canada. When considering the plants which slaughter chicken the same five account for 59% of all the chicken slaughtered in Canada. When including the next five largest companies, 81% of all the chicken slaughtered in Canada is done by ten companies (Agriculture and Agri-foods Canada). Additionally, in both countries the majority of food retail is controlled by a few number of national retailers; Coles/Newmart, Woolworths, and the Foodland group in Australia and Sobeys and Loblaws in Canada.

In these markets there is a growing interest in the balance between branded, private label and generic product. As part of a sustainable profit maximization plan, the various processors must determine optimal strategies around selling branded, where they carry the cost of product development and branding, versus selling 'generic' product to grocery stores. Different grocery chains may have different strategies they are pursuing for their store shelves, which may involve maintaining a balance between generic, branded, and their own private label products. Processors are of significantly different sizes selling to grocery store chains that are national in scope, in an industry with very thin margins. These successive stage oligopoly markets display characteristics of imperfect competition and suggest the importance of credible marketing strategies. Additionally progressive

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public and private investments in research, promotion and product development readily come under scrutiny given the market's control structure. In economic jargon these marketing strategies can be considered 'games' played by the various market participants. Given the gaming nature of industry participants and the possibility to exploit market power given the increasing concentration of market participants it becomes interesting to examine the outcomes of various strategies followed by a particular processor in light of competing processor and retailer choices. Research has shown that the types of games being played, not just the existence of imperfect competition, can impact the distribution on benefits/losses through the marketing chain (Cotterill, 2000). Ultimately market intermediaries are having an increasing influence on societal welfare in both Australian and Canadian markets.

When reviewing the literature we find that the research on pricing in a competitive environment as it relates to vertical market channels has evolved immensely. Early studies concentrate on homogeneous products and models that assume single stage market channels with competitive firms (Gardner, 1975; Heien, 1980; Kinnucan and Forker, 1987). Later McCorriston, Morgan, and Rayner (1998) maintain the homogenous product and single stage industry assumptions but relax the competitive industry assumption. More recently, studies have further divulged into imperfect competition assumptions using noncooperative game theory to investigate production differentiation, product promotion, and marginal cost assumptions as related to market structure and performance (Raju, Srinivasan, and Lal, 1990; Kadiyali, Vilcassim, and Chintagunta, 1996; Cotterill, 2000; Dhar and, Cotterill 2002). In such models rational market intermediaries determine their optimal price strategy based on their assumption of market structure and fellow intermediary response.

Recently within such studies much interest has been placed on the existence of market power. A key observation of a firm with market power is the existence of a downward sloping demand curve. Downward sloping demand curves are unique because for their existence consumers must view the firm's product as different from products of competing firms (Carlton and Perloff, 2000). Carlton and Perloff describe the importance of product differentiation.

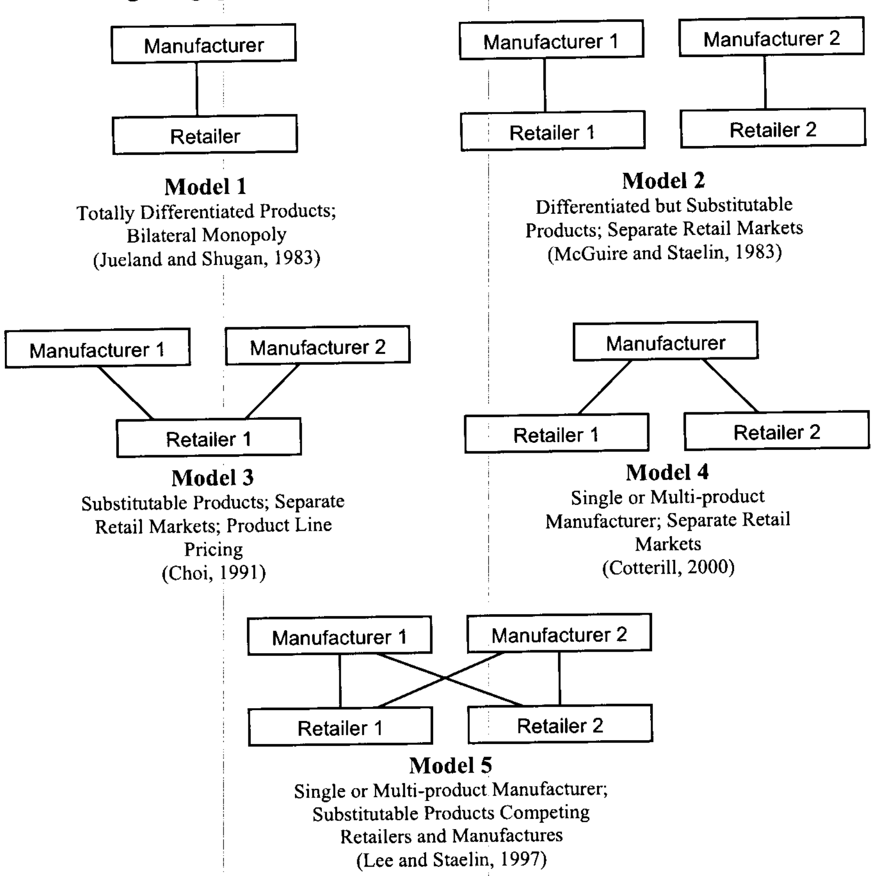
> In industries with undifferentiated products, the demand facing a particular firm depends on the total supply of its rivals, whereas in an industry with differentiated products, the demand facing a firm depends on the supply of each of its competitors separately... the more a firm succeeds in differentiating its product, the more insulated its demand is from the actions of other firms.

Therefore in a firm specific brand development strategy the costs associated with differentiating the product must be less than the incremental prices/margins that may be attainable. Only by isolating a product from other competing products, increasing the elasticity of substitution and own product demand, is it possible for a processor to exert market power and extract price/quantity premiums from the marketplace. In the scope of this research product differentiation is a major force driving brand development and marketing decisions.

It can easily be illustrated that the Australian egg and Canadian chicken markets are multiple stage, vertical market channels with producers, processors, retailers, and final customers. Given the increasing concentration of processors and retailers Cotterill (2000) and Dhar and Cotterill (2002) perhaps present the most unifying and accurate description when they describe such a market as a tight oligopoly in successive stages. Their model illustrates many producers selling to few processors, who sell to few retailers, who in turn sell to many consumers. The concentration of processors and retailers along with the consideration they must give each other when defining their optimal marketing strategies readily defines conditions necessary for an oligopoly. The concentration of market participants at two distinct intermediary levels highlights the vertical nature and successive stage oligopoly attributes. In past research conversation around vertical market structure has revolved around the issues of market power and cost/price transmission. Kinnucan and Forker (1987) contend that industry concentration in the intermediary levels provides opportunity for intermediaries to exert market power. Market power as it may be described in terms of price/cost transmission allows complete and rapid pass through of cost increases but slower and less complete transmission of cost savings. Hence a unifying theme when investigating claims of market power is the testing of pricing asymmetry. Recent studies investigating price transmission in the livestock sector include Chang and Griffith (1998) for Australia, Goodwin and Holt (1999) for the U.S. and von Cramon-Taubadel (1998) for Germany. However from a macroeconomic perspective this interstage "stickiness" of prices does not illustrate sufficient proof of market power. McCorriston, Morgan and Ryaner (2001) drawn upon a wide range of literature and argue that the stickiness of prices at processor and retail level may be due to menu costs, the costs of changing prices frequently and uncertaintly, over whether the source of the shock is permanent. This literature suggests that prices in the short run may be sticky while in the long run prices are fully adjustable because the nature of exogenous changes may be fully explored. However if a level effect persists then it is ascertainable that imperfect competition exists.

While the study of price transmission has numerous implications for the investigation of market power and societal welfare numerous approaches have been used to model the vertical nature of many industries. Simpler models essentially regress the prices a firm charges on both its costs and the costs of another firm in the industry (Ashenfelter, et al, 1998) while more involved models attempt to capture the channels structure along with participant conduct. Consequently, as Bresnahan (1989) indicates, in the spirit of "new empirical industrial organization" studies the economic challenge is to account for the endogeneity in sales (or demand) and prices for various brands in a fully structural system of equations. The task is to estimate econometric models that postulate demand and cost functions at the firm level respective of price-cost margins and market conduct. From properly specified models it becomes possible to investigate returns to research, advertising, and investment for all stakeholders. A summary of structural models used in previous empirical estimation are presented in figure 1. From these an empirical model is developed given constraints of available data.

Figure 1: Five successive stage oligopoly models.



Model 1
Totally Differentiated Products; Bilateral Monopoly (Jueland and Shugan, 1983)

Model 2
Differentiated but Substitutable Products; Separate Retail Markets (McGuire and Staelin, 1983)

Model 3
Substitutable Products; Separate Retail Markets; Product Line Pricing (Choi, 1991)

Model 4
Single or Multi-product Manufacturer; Separate Retail Markets (Cotterill, 2000)

Model 5
Single or Multi-product Manufacturer; Substitutable Products Competing Retailers and Manufactures (Lee and Staelin, 1997)

In the above figure five successive stage oligopoly models are presented. While each model appears to be unique models one to four are specialized cases of the generalized case, model five. In model one Jeuland and Shugan (1983) illustrate a bilateral monopoly where manufacturer products are sufficiently differentiated such that they are no longer substitutable. Each product competes in a separate market as a monopoly good. Model 5 can be viewed as a bilateral monopoly when products are homogenous and marginal costs are equal. Final consumption is solely determined by consumers. In model two McGuire and Staelin (1983) present a case with multiple manufactures and retailers but with partial differentiation and exclusive manufacturer retailer relationships. Partial differentiation segregates the markets such that retailers serve completely different markets but exclusive dealing prevents manufactures from offering products to the opposing retailer. In model three Choi (1991) illustrates a case where two manufacturers supply a single retailer with differentiated products such that retailers implement product line pricing to service different market segments. Model four assumes the converse with a single manufacturer supplying multiple retailers (Cotterill, 2000). The manufacturer can provide the retailers with homogeneous products or differentiate products. Demand for the manufacturer's product is derived by the competition between retailers. Model five in the generalized case where multiple manufactures offer homogenous of differentiated products to multiple retailers (Lee and Staelin, 1997). By instituting various rules, restrictions or product offering any of the previous four models can be derived from it.

Beyond the specification of market structure other researchers have incorporated strategic action or market conduct thus incorporating oligopoly game theory into their market channel description. Some of these researchers include Choi (1991), Cotterill (2000), Dhar and Cotterill (2002), and Lee and Staelin (1997). Choi (1991) illustrates three games played between retailers and manufactures that become the basis for research presented by Cotteril, Dhar, Lee, and Staelin. Choi recognizes that prior research has focused on manufacturer dominance over retailers but because the power balance between channel members affects the equilibrium prices and profits Choi believes alternative market assumptions must be investigated as well. Choi's models assume that although products may be differentiated they are highly substitutable. Assuming substitutability and short-term production constraints there is a greater potential for price (Bertrand) competition versus quantity (Cournot) competition. The three models proposed by Choi (1991) are

> Vertical Nash (VN). Each manufacturer chooses its wholesale price conditional on both the retailer's margin on its own product and the observed retail price of the competing brand. The retailer determines the margin of each brand conditional on the respective wholesale prices. Each manufacture maximizes returns by maintaining a strategy consistent with the prices suggested by the first order condition of its own profit function.
>
> Manufacturer-Stackelberg (MS). Each manufacturer chooses the wholesale price using the response function of the retailer, conditional on the observed price of the competitor's product. The retailer determines the price of each product so as to maximize total profit from both brands given the respective wholesale prices. As Cotterill (2000) adds, competition between manufacturers is seen as a vertical game through retailers rather than a direct horizontal game among processors at the wholesale level
>
> Retailer-Stackelberg (RS). Each manufacturer chooses its wholesale price conditional on both the retailer's margin on its own product and the observed retail price of the competing brand. The retailer determines the margin of each brand using the reaction functions of both manufacturers in terms of respective wholesale prices.

These vertical structure models when combined with different market conducts attempt to satisfy our economic challenge by presenting numerous variations of fully structural equation systems. However, incorporating simultaneous retailer and processor strategic action requires very comprehensive data sets such as those utilized by Liang (1987. These data sets utilize not only retail prices but also wholesale prices to determine retail markup decisions. In the absence of wholesale prices (or instrumental variables) only retailer or processor horizontal competition can be empirically investigated. Given the lack of wholesale prices for

Australian eggs and Canada chicken the theoretical model presented next and later used for empirical estimation only investigates processor strategic action. Therefore this research must be thought of as a initial step helping to identify processor conduct within a larger structural framework.

Model Development

When assessing previous research regarding competitive interaction in oligopoly markets studies have taken three unique empirical forms, they include a menu approach or nonnested model comparison, conjectural variation (CV) models, and time series causal or Granger causality approach (Putsis and Dhar, 1998; Kadiyali, Vilcassim and Chintagunta, 1996).

Menu or nonnested menu approaches for estimating competitive interaction require specification of the various forms of competitive interaction to be considered (e.g., Nash-Cournot, Nash-Bertrand, Stackelberg). Which model fits the data best is then ascertained by significance tests, the lowest sum of squared errors (if using 3SLS), the lowest log-likelihood ration (if FIML is used) or by non-nested tests similar to the type introduced by Vuong (1989). The menu approach gets its name because researchers infer firm behavior based upon which model interacts with the data best. Previous research using this approach includes Gasmi and Vuong (1991), Gasmi, Laffont and Vuong (1992), Raju, Sethuraman, and Dhar, and Kadiyali, Vilcassim and Chintagunta (1996). When comparing Raju, Sethuraman, and Dhar and Kadiyali, Vilcassim and Chintagunta we find two unique menu approaches. Raju, Sethuraman, and Dhar present an analytical framework to investigate what makes a product category more conducive for store brand introduction. In this frame work they use simple two tailed significance tests to investigate contrasting models investigating two general hypotheses; (1) other things being equal, private labels are more likely to be introduced in categories with smaller cross-price sensitivity among national brands and a larger number of national brands and (2) other things being equal, market share of private labels will be higher in product categories with smaller cross-price sensitivity among national brands and a smaller number of national brands. Significance tests performed on models varying price sensitivities, number of national brands and number of store brands suggest that store brand introduction is likely to increase retailer profit if cross-price sensitivity among national brands is low and cross-price sensitivity between the national brand and the store brand is high. In contrast Kadiyali, Vilcassim and Chintagunta use the menu approach to investigate market conduct. In this research Bertrand-Nash pricing is compared against Stackelberg pricing rules. Interest in this approach recognizes that with the use of market-level not individual consumer-level data price and sales data cannot be treated as exogenous variables. Prices determination is not only a function of demand but also the pricing rules or conduct of producers, manufacturers and retailers. Using 3SLS and the lowest sum of squared errors as a decision criteria Kadiyali, Vilcassim and Chintagunta reject Bertrand-Nash pricing in favor of Stackelberg pricing. Since the elasticities generated in either model are significantly different the authors suggest that market own- and cross-price elasticities are dependant upon what one assumes for the underlying price-setting behavior. Ultimately the menu approach offers a procedure of ad hoc tests for fitting a particular model to observed data.

Conjectural variation (CV) models in comparison to menu approaches do not specify a particular conduct. Based on early work by Iwata (1974), Gallop and Roberts (1979), Spiller and Favaro (1984) and Gelfand and Spiller (1987) CV models estimate a conjectural variation or "conduct" parameter that may measure behavioral deviation from Cournot-Nash or Bertrand-Nash behavior (Liang, 1987; Putsis and Dhar, 1998; Cotterill, Putsis, and Dhar, 2000). In the former statement if both firms have a conduct parameter equal to zero than Nash behavior is assumed and if one firm has a conduct parameter equal to one that a Stackleberg relationship is observed. Research utilizing CV models include Liang (1987), Conrad (1989), Gasmi, Laffont, and Vuong (1992), Dhar, et al (2002), Friedman and Mezzetti (2002) and Kinoshita, Suzuki, and Kaiser (2002). To illustrate the CV approach Liang (1987) is used. While being one of the first substantial CV models the research utilizes one on the most complete data sets found in the literature. Not only are retail and producer prices and quantities available so are manufacturer wholesales prices. While other studies have assumed a fixed marginal cost at the manufacturer level (Kadiyali, Vilcassim and Chintagunta, 1996) the availability of true wholesale prices allows for successive estimation of price-cost markups throughout the marketing chain. As a result vertical interaction between manufacturers and processors can be appropriately modeled and estimated. In this research Liang uses a conduct parameter to estimate independent or collusive behavior, where independent behavior is assumed to be Bertrand-Nash conduct and collusive behavior is seen as Stackelberg behavior. As an ad hoc analysis of the data gathered during the US Federal Trade Commission antitrust case brought against Kellogg, General Mills, and General Foods in the 1970's Liang models demand as a function of own-price elasticities, cross-price elasticities, and conjectural response elasticity. The parameter on the conjectural response is constrained between zero and one and indicates increasing collusive behavior as it approaches one. Liang finds that the amount of independent or collusive interaction is market dependent. These companies exhibit highly arranged or reactionary strategies in some markets while in other markets their actions seem independent of each other. Liang's use of the CV model in a fully structural system is seen as one of the first empirical studies to investigate both processor and retailer interaction. Undoubtedly others will follow.

Time series casual or Granger causality tests utilize time series data and causality tests to confirm firm reactions toward each other (Putsis and Dhar, 1998). For example if firm 2 choose it optimal behavior after observing firm 1's behavior and vice versa the observed choices are related time series events. Systematic investigation over time may illustrate causality relationships. This approach is particularly useful to confirm leader-follower relationships as determined by menu approaches or CV models. This approach may be particularly useful in examining dynamic relationships where firms are assumed to complete repeatedly over time in mega-games instead of a single period game. Investigation in this paper uses a menu approach similar to that presented by Kadiyali, Vilcassim and Chintagunta (1996).

To begin model development an initial complication is recognized. While it is true that in a fully structural model wholesale prices are endogenously determined, the price information available is at the retail level. Using the following reasoning, similar to that illustrated by Kadiyali, Vilcassim, and Chintagunta (1996) for product line pricing, we can abstract from the role of the retailer to develop processor conduct.

Think of the following sequence of moves being played in the market (repeatedly): processors price their product(s) to the retailers and advertise, taking into account rival pricing policies and advertising behavior as well as retailer behavior. While advertising by processors is usually assumed for branded products only, processors may engage in generic advertising if speculated returns warrant investment. Retailers then determine the retail price and private label advertising. When processors take these rules as given the interaction between processors and retailers is assumed to be Nash: processors choose their wholesale prices and advertising investment as a response to retailer advertising. An important assumption is that retailers do not compete horizontally within a particular product category. This assumption when considering producer-retailer Nash interaction is similar to assuming fixed markup pricing rule in setting retail prices. Should retailers strategically set retail prices and advertising both retail and wholesale prices would be required for empirical estimation.

Let the demand facing each firm to be linear in prices and represented as follows,

$$q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i \qquad 1$$

where $i = 1 \ldots n$, $j = 1 \ldots n$, n equals the number of processors being considered, q and p represent the quantities and prices, α_i, and γ_{ij} represent demand parameters to be estimated and X_i represent other exogenous variables and parameters used for empirical estimation. Using economic theory, non-sample information is used to impose homogeneity of degree zero in prices and price symmetry (i.e $\gamma_{ij} = \gamma_{ji}$). Homogeneity of degree zero is imposed by dividing each price by the consumer price index (*CPI*). The imposition of price symmetry is seen as a unique approach to this research. Previous research has not accounted for price symmetry in demand as can be derived from consumer preference theory.

Processor profit functions can be illustrated as

$$\pi_i = (p_i - mc)q_i \qquad 2$$

where π_i and mc represent profit and marginal cost of production for processor i. Note given the lack of production cost information producer/farm gate prices are used as an estimate of mc.

In the Bertrand-Nash game each processor develops a marketing strategy by optimizing their own price with respect their own profit function. This type of competition models direct horizontal price competition between processors. The following first order condition (FOC) can be derived,

$$\frac{\partial \pi_i}{\partial p_i} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + \sum_{j=1}^{n} \frac{\lambda_{ij}}{adv_j} + X_i + \gamma_{ii} \frac{(p_i - mc_i)}{CPI} = 0 \qquad 3$$

Solving the FOC for p_i we derive a price reaction function for processor i as

$$p_i = -\frac{1}{2g_{ii}} \left(a_i CPI + \sum_{i \neq j} g_{ij} p_j + X_i CPI \right) + \frac{mc}{2} \qquad 4$$

Combining demand equations and price reaction functions the following system of equations exists for empirical estimation.

$$q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i + \varepsilon_i \qquad 5a$$

$$p_i = -\frac{1}{2g_{ii}} \left(a_i CPI + \sum_{i \neq j} g_{ij} p_j + X_i CPI \right) + \frac{mc}{2} + \varepsilon_{i+n} \qquad 5b$$

The errors ($\varepsilon_1 \ldots \varepsilon_{n+i}$) are econometric estimation errors that result when missing data or uncertainty is encountered. As will be illustrated these errors warrant the use of seemingly unrelated regression (SUR) rather than individual estimation of the above equations.

In a price leadership or Stackelberg game one processor (processor k, where $k = 1 \ldots n$, but $k \neq i$) is chosen as the leader and all other firms follow. The leader develops a marketing strategy accounting for the optimal marketing decision of the followers. The choice of an initial leader is not important as long as each other processor is given the opportunity to lead. Because initially the true model is unknown estimation of various possibilities is important because it "lets the data speak" and helps avoids researcher estimation bias (Kadiyali, Vilcassim, and Chintagunta, 1996). In this example the followers' FOCs and simplified price reaction functions are,

$$\frac{\partial \pi_i}{\partial p_i} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + \sum_{j=1}^{n} \frac{\lambda_{ij}}{adv_j} + X_i + \gamma_{ii} \frac{(p_i - mc_i)}{CPI} = 0 \qquad 6a$$

$$p_i = -\frac{1}{2g_{ii}} \left(a_i CPI + \sum_{i \neq j} g_{ij} p_j + X_i CPI \right) + \frac{mc}{2} \qquad 6b$$

where $k \neq i$.

In the following four steps the leader's price reaction function is developed by substituting the followers' reaction functions into the leader's maximand. First, the leaders profit function is defined.

$$\pi_k = (p_k - mc) q_k \qquad 7$$

Second, the demand equation for the leader's product is substituted into the profit function.

$$\pi_k = (p_k - mc)\left(\alpha_{ki} + \sum_{i=1}^{n} \gamma_{ki} \frac{p_i}{CPI} + X_k\right) \qquad 8$$

Third, the leader forms a conjecture about the followers conduct, substituting the followers' price reaction functions from equations 4.8 into its own profit function, equation 4.7, to replace all p_i $(k \neq i)$. Lastly, completing the leader's FOCs and solving with respect to p_k the leader's price reaction function is defined.

$$p_k = -\frac{1}{2\gamma_{kk} - \sum_{j\neq k} \frac{\gamma_{ki}^2}{\gamma_{ii}}}\left(a_k CPI + \sum_{j\neq i} \gamma_{ki} p_i + X_k CPI - mc\left(\gamma_{kk} - \sum_{j\neq i} \frac{\gamma_{ki}^2}{\gamma_{ii}}\right)\right) \qquad 9$$

Combining demand equations and price reaction functions the following system of demand equation exists for empirical estimation.

$$q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i + \varepsilon_i \qquad 10$$

$$p_k = -\frac{1}{2\gamma_{kk} - \sum_{j\neq k} \frac{\gamma_{ki}^2}{\gamma_{ii}}}\left(a_k CPI + \sum_{j\neq i} \gamma_{ki} p_i + X_k CPI - mc\left(\gamma_{kk} - \sum_{j\neq i} \frac{\gamma_{ki}^2}{\gamma_{ii}}\right)\right) + \varepsilon_{k+n} \qquad 11$$

$$p_i = -\frac{1}{2g_{ii}}\left(a_i CPI + \sum_{i\neq j} g_{ij} p_j + X_i CPI\right) + \frac{mc}{2} + \varepsilon_{i+n} \text{ where } i = 1 \ldots n, \text{ excluding } i = k. \qquad 12$$

Given the available data exogenous variables summarized in X_i and used for empirical estimation are illustrated as follows

Australia

$$X_i = \sum_{j\neq 1}^{n} \frac{\lambda_{ij}}{\left(\frac{adv_j}{CPI}\right)} + \mu_{i1} Time + \mu_{i2} Exp + \mu_{i3} q_i(-1) \qquad 13$$

Canada

$$X_i = \mu_{i1} Time + \mu_{i2} Exp + \mu_{i3} q_i(-1) \qquad 14$$

where adv_i is advertising expenditure by firm *i*, *Time* is a time trend index, *Exp* is expenditure, $q_i(-1)$ is a lagged dependent variable, and λ and μ are parameters to be estimated. Advertising has been divided by the CPI to yield real advertising expenditures. The incorporation of advertising as an inverse relationship imposes diminishing returns to advertising.

Data, Estimation and Results

For both Australian eggs and Canadian chicken markets retail price and quantity data was provided by AC Neilsen. As mentioned earlier the provision of solely retail level data restricts investigation of a fully structural model. One can only investigate either processor or retailer actions given the absence of wholesale. Since the emphasis in this research surrounds processor actions we abstract processor action from retail level data by assuming a retailer fixed markup policy.

For Australian eggs, quarterly retail price and quantity data is provided for brand and private label categories for the period 1998:2 to 2002:4. The three largest brands, Sunny Queen, Pace Farms, and Farm Pride, and private label eggs are assumed to be major market brands. The remaining egg production not accounted for by these four is assumed to be generic egg product. Current market shares calculated by volume are private label 60%, an increase of 40% since 1998, Pace Farms 12%, Sunny Queen and Farm Pride each 5% and generic eggs 18%. Additionally national media advertising expenditure, provided by AC Nielsen, exists for an over lapping period. Pace Farms, Sunny Queen, and Farm Pride nationally advertise while private label and generic processors did not. Absent in this advertising data is store display information. Store displays have been included in similar studies as demand shifters (Kadiyali, Vilcassim, and Chintagunta, 1996). Yearly average producer prices, used to represent *mc*, were obtained from the Australian Egg Corporation Limited (2002). Linear interpolation was used to derive quarterly estimates. Quarterly CPI estimates were obtained from the Australian Bureau of Statistics.

For Canada fresh chicken quarterly retail price and quantity data was available from the first week of 2001 through to the 44th week 2003. In contrast to Australian eggs the majority of fresh chicken in Canada is marketed as generic product. Market shares on average are approximately 1% Lilydale Gold, 5% Maple Leaf Prime, and 93% generic. Aggregated in the generic category are the following brands; 44th Street Chicken, Exceldor, Flamingo, Janes, Jims, Organic Kitchen, Sausages, St. Hubert, and Sterling Silver. Together these nine brands make up less than one percent of fresh chicken and are not considered as major brands. Neither generic nor brand specific advertising data was available for Canadian chicken. Average weekly producer prices were obtained from Agriculture and Agri-food Canada Online. Given the concentration of Maple Leaf and generic processing in eastern Canada, Ontario producer prices were used as estimates for generic and Maple Leaf processors while for Lilydale, primarily a western processor, Albertan producer prices were used. Linear interpolation was used to translate monthly CPI estimates, as obtained from Statistics Canada, Canadian Socio-Economic Information Management System (Cansim II), into weekly CPI measures. In the appendix, figures A1-A7 graphically depict price, quantity and advertising data.

Given the systems of equations to be estimated joint estimation of equations was carried out by seemingly unrelated regression (SUR). Joint estimation was completed not only to imposed cross equation restrictions, namely price symmetry, but also to address the likelihood of cross equation error (ε) correlation. When empirically estimating theoretical equations economic error term (ε_i) are attached. These ε_i accumulated dependent variable variation not accounted for in by explanatory variables. Factors omitted from an equation including missing data, omitted explanatory variables and/or uncertainty are included in ε_i. Since there is a likelihood that information omitted from one equation may also had been omitted from another there is likely contemporaneous correlation of error. SUR estimation adjusts for contemporaneous correlation of errors by estimating error covariances. The resultant variance-covariance matrix used in the estimator has off diagonal, i.e. error covariance terms, not equal to zero. Accounting for cross equation error correlation make SUR and unbiased estimator of our model.

Using Times Series Processor (TSP) software SUR was performed. For Australia five egg processors were assumed: Pace Farms, Sunny Queen, Farm Pride, private label, and generic. Using the generalized equation system format previously illustrated, six SUR estimations were completed; one Bertrand-Nash model and five Stackelberg models giving each processor a chance to lead. For Canada similar estimations were made assuming three processors: Lily Dale, Maple Leaf Prime, and generic. Own-price elasticity of demand cross-price elasticity of demand, advertising elasticities (Australia only), and price reaction equation elasticities are illustrated in tables 1-5.

Table 1: Bertrand-Nash and Stackelberg model own and cross price demand elasticities for Australian Eggs

	Bertrand	Stackelberg Sunny Queen	Stackelberg Pace Farms	Stackelberg Farm Pride	Stackelberg Private Label	Stackelberg Generic
Own Price Elasticity						
ε 11	-1.386*	-1.462*	-1.454*	-1.383*	-1.454*	-1.377*
ε 22	-2.365*	-2.370*	-2.415*	-2.353*	-2.361*	-2.287*
ε 33	-1.320*	-1.310*	-1.388*	-1.386*	-1.354*	-1.317*
ε 44	-1.428*	-1.451*	-1.448*	-1.431*	-1.390*	-1.444*
ε 55	-2.369*	-2.369*	-2.064*	-2.356*	-2.390*	-3.295*
Cross Price Elasticity						
ε 12	-0.041	-0.037	-0.036	-0.070	-0.002	0.147
ε 13	0.555*	0.571*	0.543*	0.576*	0.538*	0.401*
ε 14	0.170	0.163	0.239	0.151	0.106	-0.204
ε 15	0.702	0.798**	0.719	0.714	0.709	0.163
ε 21	-0.042	-0.038	-0.037	-0.072	-0.002	0.151
ε 23	-0.628*	-0.631*	-0.665*	-0.627*	-0.629*	-0.575*
ε 24	0.770*	0.777*	0.913*	0.783*	0.768*	0.553*
ε 25	1.083**	1.054*	0.969*	1.091*	1.044*	1.867*
ε 31	0.802*	0.825*	0.786*	0.833*	0.778*	0.581*
ε 32	-0.884*	-0.887*	-0.936*	-0.882*	-0.885*	-0.809*
ε 34	-0.414	-0.414	-0.561*	-0.410**	-0.393	0.027
ε 35	-0.737	-0.720	-0.382	-0.728	-0.720	-2.118*
ε 41	0.069	0.066	0.097	0.061	0.043	-0.083
ε 42	0.303*	0.306*	0.360*	0.309*	0.303*	0.218*
ε 43	-0.116	-0.116	-0.157*	-0.115**	-0.110	0.007
ε 45	1.539*	1.536*	1.308*	1.524*	1.603*	2.347*
ε 51	0.185	0.210**	0.189	0.188	0.187	0.043
ε 52	0.278*	0.270*	0.248*	0.280*	0.268*	0.478*
ε 53	-0.134	-0.131	-0.070	-0.133	-0.131**	-0.386*
ε 54	1.002*	1.000*	0.851*	0.992*	1.043*	1.527*

* Significance assume at P≤0.05
** Significance assume at P≤0.10
Where for ε *ij*, *i* takes the values: 1-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, 5-Generic

Table 2: Bertrand-Nash and Stackelberg model advertising elasticities for Australian Eggs

	Bertrand	Stackelberg Sunny Queen	Stackelberg Pace Farms	Stackelberg Farm Pride	Stackelberg Private Label	Stackelberg Generic
Advertising Elasticity						
ε *adv*11	2.50E-05	2.51E-05	2.47E-05	2.55E-05	2.72E-05	4.88E-05*
ε *adv* 12	-2.16E-05*	-2.19E-05*	-2.18E-05*	-2.16E-05*	-2.20E-05*	-2.48E-05*
ε *adv* 13	-1.94E-03*	-1.97E-03**	-1.92E-03*	-1.96E-03*	-1.97E-03*	-2.88E-03*
ε *adv* 21	7.71E-06	7.74E-06	3.26E-06	7.38E-06	8.40E-06	1.46E-05
ε *adv* 22	-1.28E-05	-1.27E-05	-1.21E-05	-1.28E-05	-1.29E-05	-1.65E-05
ε *adv* 23	-1.89E-05	-3.15E-05	1.08E-04	-2.00E-05	-3.39E-05	-2.19E-04
ε *adv* 31	7.52E-06	7.24E-06	1.03E-05	7.79E-06	6.49E-06	-4.09E-06
ε *adv* 32	4.70E-06	4.52E-06	4.03E-06	4.67E-06	4.69E-06	9.68E-06
ε *adv* 33	5.89E-04	6.03E-04	4.16E-04	5.82E-04	6.39E-04	1.07E-03
ε *adv* 41	-3.44E-05	-3.41E-05	-3.32E-05	-3.45E-05	-3.60E-05	-4.47E-05
ε *adv* 42	2.28E-05*	2.31E-05*	2.34E-05*	2.28E-05*	2.32E-05*	2.44E-05*
ε *adv* 43	3.82E-03*	3.84E-03*	3.82E-03*	3.81E-03*	3.79E-03*	4.18E-03*
ε *adv* 51	1.54E-05	1.53E-05	1.78E-05	1.56E-05	1.40E-05	3.97E-06
ε *adv* 52	-3.56E-06	-3.59E-06	-4.44E-06	-3.58E-06	-3.51E-06	-1.64E-08
ε *adv* 53	-1.51E-03*	-1.50E-03*	-1.63E-03*	-1.51E-03*	-1.44E-03*	-9.94E-04*

* Significance assume at P≤0.05
** Significance assume at P≤0.10
Where for ε *adv ij, i* takes the values: 1-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, 5-Generic

Table 3: Bertrand-Nash and Stackelberg model price reaction equation elasticities for Australian Eggs

	Bertrand	Stackelberg Sunny Queen	Stackelberg Pace Farms	Stackelberg Farm Pride	Stackelberg Private Label	Stackelberg Generic
Price Reaction Elasticity						
ε p1(p2)	-0.015	-0.014	-0.012	-0.025	-0.001	0.053
ε p1(p3)	0.200*	0.211*	0.187*	0.208*	0.185*	0.146*
ε p1(p4)	0.061	0.060	0.082	0.055	0.036	-0.074
ε p2(p4)	0.212	0.248**	0.207	0.216	0.204	0.050
ε p2(p1)	-0.009	-0.008	-0.008	-0.015	0.000	0.033
ε p2(p3)	-0.133*	-0.133*	-0.150*	-0.133*	-0.133*	-0.126*
ε p2(p4)	0.163*	0.164*	0.206*	0.166*	0.163*	0.121*
ε p2(p5)	0.192*	0.186*	0.183	0.194*	0.185*	0.342*
ε p3(p1)	0.304*	0.315*	0.283*	0.341*	0.287*	0.220*
ε p3(p2)	-0.335*	-0.339*	-0.337*	-0.361*	-0.327*	-0.307*
ε p3(p4)	-0.157	-0.158	-0.202	-0.168**	-0.145	0.010
ε p3(p5)	-0.234	-0.231	-0.115	-0.250	-0.223	-0.675*
ε p4(p1)	0.024	0.023	0.033	0.021	0.018	-0.029
ε p4(p2)	0.106*	0.105*	0.124*	0.108*	0.128*	0.075*
ε p4(p3)	-0.041	-0.040	-0.054*	-0.040	-0.047	0.003
ε p4(p5)	0.452*	0.444*	0.379*	0.447	0.569*	0.681*
ε p5(p1)	0.039	0.044**	0.046	0.040	0.039	0.009
ε p5(p2)	0.059*	0.057*	0.060*	0.059*	0.056*	0.099*
ε p5(p3)	-0.028**	-0.027**	-0.017	-0.028**	-0.027**	-0.028*
ε p5(p4)	0.211*	0.211*	0.206*	0.211*	0.218*	0.316*
ε p1(mc)	0.182***	0.167*	0.182***	0.182***	0.182***	0.182***
ε p2(mc)	0.178***	0.178***	0.160*	0.178***	0.178***	0.178***
ε p3(mc)	0.185***	0.185***	0.185***	0.160*	0.185***	0.185***
ε p4(mc)	0.207***	0.207***	0.207***	0.207***	0.170*	0.207***
ε p5(mc)	0.173***	0.173***	0.173***	0.173***	0.173***	0.111*

* Significance assume at P≤0.05.
** Significance assume at P≤0.10.
***Denotes a constant, rather than an estimated elasticity.
Where ε p*i*(p*j*), is the price reaction equation elasticity for processor *i* with respect to price *j*
Where ε p*i*(mc), is the price reaction equation elasticity for processor *i* with respect to marginal cost.
i and *j* take the values: 1-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, 5-Generic.

Table 4: Bertrand-Nash and Stackelberg model own and cross price demand elasticities for Canadian Chicken

	Bertrand	Stackelberg Lilydale	Stackelberg Maple Leaf	Stackelberg Generic
Own Price Elasticity				
ε 11	-1.366*	-0.586*	-1.351*	-1.374*
ε 22	-0.699*	-0.720*	-0.383*	-0.709*
ε 33	-1.135*	-1.155*	-1.112*	-1.131*
Cross Price Elasticity				
ε 12	1.516*	1.369*	1.987*	1.501*
ε 13	-0.659**	-1.082*	-0.944*	-0.598**
ε 21	0.231*	0.208*	0.302*	0.228*
ε 23	0.096	0.253	-0.161	0.060
ε 31	-0.010**	-0.016*	-0.014*	-0.009**
ε 32	0.009	0.025	-0.016	0.006

* Significance assume at P≤0.05
** Significance assume at P≤0.10
Where for ε *ij*, *i* takes the values: 1-Lilydale, 2-Maple Leaf, 3-Generic

Table 5: Bertrand-Nash and Stackelberg model price reaction equation elasticities for Canadian Chicken

	Bertrand	Stackelberg Lilydale	Stackelberg Maple Leaf	Stackelberg Generic
Price reaction Elasticity				
ε p1(p2)	0.555*	1.416*	0.735*	0.546*
ε p1(p3)	-0.241*	-1.119*	-0.349*	-0.217**
ε p2(p1)	0.165*	0.145*	0.558*	0.161*
ε p2(p3)	0.069	0.175	-0.298	0.042
ε p3(p1)	-0.004*	-0.007*	-0.006*	-0.004**
ε p3(p2)	0.004	0.011	-0.007	0.003
ε p1(mc)	0.270***	0.212*	0.270***	0.270***
ε p2(mc)	0.310***	0.310***	0.182*	0.310***
ε p3(mc)	0.470***	0.470***	0.470***	0.469*

* Significance assume at P≤0.05.
** Significance assume at P≤0.10.
***Denotes a constant, rather than an estimated elasticity.
Where ε *pi*(*pj*), is the price reaction equation elasticity for processor *i* with respect to price *j*
Where ε *pi*(mc), is the price reaction equation elasticity for processor *i* with respect to marginal cost.
i and *j* take the values: 1-Lilydale, 2-Maple Leaf, 3-Generic

Selection of the best fitting model has taken numerous approaches in the literature. Vuong (1989) suggested likelihood ratios for non-nested hypothesis testing. Comparatively Kadiyali, Vilcassim, and Chintagunta (1996) suggest the use of lowest log of the likelihood function or lowest sum of squared errors (SSE). Give the SUR does not optimize using a likelihood function the lowest SSE was used to determine the best fitting model.

Selection of the best or appropriate model from a menu of choices has taken a variety of approaches in the literature. Vuong (1989) illustrates an in-depth selection criterion by presenting likelihood ratio tests for non-nested hypothesis testing. Simpler approaches also using the likelihood ratios simply state the best model as the one with the lowest log-likelihood ratio. However, given that SUR estimation does not use a likelihood function for convergence and parameter estimation the best fitting model may be interpreted to be the one with the lowest sum of squared errors (SSE) (Kadiyali, Vilcassim, and Chingtagunta, 1996).

For Australian and Canadian models the SSE may be calculated as the sum of squared differences between the observed prices and those predicted by the price reaction equations. The model with the lowest SSE may then be interpreted as the best fitting model. Tables 6 and 7 illustrate SSE results.

Table 6: Sum of squared errors for Australian egg Bertrand-Nash and Stackelberg models by price reaction equation and in total.

	Bertrand	Stackelberg Sunny Queen	Stackelberg Pace Farms	Stackelberg Farm Pride	Stackelberg Private Label	Stackelberg Generic
Price Reaction Equation						
Sunny Queen	4.188	4.668	3.777	4.695	3.878	5.079
Pace Farms	4.544	4.650	2.059	5.319	3.051	2.537
Farm Pride	7.569	8.318	5.603	13.250	5.964	5.978
Private Label	6.332	6.150	6.249	6.431	10.346	9.710
Generic	3.009	2.996	1.504	3.132	1.863	0.580
Total	25.643	26.782	**19.193***	32.829	25.101	23.885

*Preferred model

Table 7: Sum of squared errors for Canadian fresh chicken Bertrand-Nash and Stackelberg models by price reaction equation and in total

	Bertrand	Stackelberg Lilydale	Stackelberg Maple Leaf	Stackelberg Generic
Price Reaction Equation				
Lilydale	1033	11939	16894	986
Maple Leaf	1365	2298	23272	1285
Generic	121	113	101	121
Total	2519	14350	40267	**2393***

*Preferred model

In Australian and Canadian markets we reject Bertrand-Nash competition and confirm the identity of a Stackelberg leader. In Australia the leader is Pace Farms while in Canada generic leads. In the appendix, figures A8 and A9 report goodness of fit statistics for the preferred Australian and Canadian models.

The selection of the best fitting model for a particular market illustrates the rejection of Bertrand-Nash behavior in both Australia and Canada. The market data indicates that in terms of volume and value private label and generic processors in Australia lead the market while in Canada generic product leads the market. However the best fitting model suggests that Pace Farms leads in Australia while generic leads in Canada. While these may be the best fitting game, what do they mean?

The rejection of Bertrand behavior illustrates that the leading firms are using foresight to optimize their profits. Given demand and cost conditions they anticipate follower pricing reactions and set their prices accordingly. Followers observe the leaders decision and set prices in a reactionary fashion. This dynamic relationship may seem counter intuitive to the one-shot game modeled in this research but is supported in the literature. From the literature three explanations emerge which suggest why firms may follow the more accommodating leader/follower relationship rather than the more competitive Bertrand-Nash interaction.

In the first explanation a few theoretical models and experimental pieces suggest that when game participants meet repeatedly , they move away from competitive or Bertrand Nash behavior to more cooperative outcomes, Stackelberg (Axelrod, 1982; Kreps, et al, 1982; Friedman, 1990). Over infinite time horizons repeated game play easily evolves to more collusive behavior but more importantly so does repeated play in finite horizons. Speculated by these researchers is the evolution of several simple to formulate and easy to implement monitoring and punishment strategies. These strategies are designed to promote higher profits for all participants if participants interact according to their competition's expectations.

Another explanation for observing Stackelberg behavior may be multimarket contact (Bernhein and Whinston, 1990). In the Australian egg market processors not only compete in the shell egg market but additionally in the broken shell market. The broken shell market consists of further processed products which usually achieve higher returns. In Canada we modeled fresh chicken consumption. Frozen chicken and restaurant demands were not included and likely make up a large portion of chicken demand. The primary assumption behind this theory is that profits are higher under cooperative action. Therefore noncooperative behavior in one market reduces the credibility of players to signal willingness to cooperate in other markets. In turn Bertrand-Nash behavior in one market may force non-cooperative behavior in other markets and lower profits for all participants.

The third explanation illustrating the evolution towards Stackelberg interaction rather than Bertrand-Nash revolves around product positioning. There are two opposing views concerning how firms should position their products in attribute space. The first as suggested by Hoteling (1927) suggests that firms should position products as far away from competing products in order to serve different market segments. The largest brand than becomes the one serving the largest market segment however the most proportionately profitable firm becomes the one that best provides its segment with the attributes it promised at the lowest product cost. Conversely Klemperer (1992) advocates head-to-head competition. Under head-to-head competition when firms market similar products they share consumers with their rivals. Consequently the temptation to increase prices is countered by movement of consumers to the lower priced good. Conversely price decreases must be matched by rivals as consumers will again migrate to the lower priced item. Therefore a strategy using price decreases to gain market share ultimately lowers market prices and profits for all participants. To see the implications of this last explanation let us examine price elasticities.

When investigating own-price elasticities (ε_{ii}) product space theory suggests that lower own-product elasticity products are viewed by consumers as being further away in product space. This means the consumers see them as differentiated products serving a unique or slightly segregated market segment. Conversely proportionately higher own-price elasticity products in consumer space are view as readily competing with each other. Given the illustrated elasticities choice of appropriate product positioning is determined by how participants view competition. If participants view niche creation as softening competition, moving towards more collusive behavior, and observe a low own-price elasticity they will want to position their product as differentiated. In Canada Maple Leaf readily displays this assumption. While not being the leader, Maple Leaf has recently taken an active stance to differentiate it's product from others through selective feeding programs. Their birds, fed only a vegetable-grain ration, are marketed as an alternative to conventional chicken which is produced on rations that may contain animal by-products. As such they readily apply poultry rearing rations as a differentiation technique, a technique which allows them to consistently demand higher prices over generic. In Australia the market leader, Pace Farms, displays the converse assumption, assuming that head-to-head competition reduces competition. Given that Pace Farms displays one of the highest own-price elasticities they cannot claim to be a differentiated product. However, examining retail prices Pace is never the high priced item, nor is it the lowest. It remains competitively price in relation to other products. However, private label has made ready use of its lower own-price elasticity when competing against its major volume competitor, generic. Generic product generally does not invest in product differentiation techniques, however in Australia, generic product has the highest retail price. Observing a lower price elasticity private label has able to substantially cut prices starting in 2000:4 and make huge market gains largely at the expense of generic. Positioning itself as the low cost industry leader has readily allowed private label to exploit its lower own-price elasticity and make huge gains in volume and value.

To investigate cross-price elasticity (ε_{ij}) relationships the following two tables summarizes elasticities for our preferred models. Elasticities not significant at the $P \leq 0.10$ are assumed to be zero.

Table 6: Summary of significant elasticities for Australian eggs Stackelberg-Pace Farms model.

	Demand for:				
	Sunny Queen	Pace Farms	Farm Pride	Private Label	Generic
Price of:					
Sunny Queen	-1.454	0	0.786	0	0
Pace Farms	0	-2.415	-0.936	0.360	0.248
Farm Pride	.543	-0.665	-1.388	-0.157	-0.070
Private Label	0	0.913	-0.561	-1.448	0.851
Generic	0	0.813	-0.320	1.097	-1.731

Zero estimates represent non-significant results with significance assumed at $P \leq 0.10$.

Table 7: Summary of significant elasticities for Canadian fresh chicken Stackelberg-Generic model

	Demand for:		
	Lilydale	Maple Leaf	Generic
Price of:			
Lilydale	-1.374	0.228	-0.009
Maple Leaf	1.501	-0.709	0
Generic	-0.598	0	-1.131

Zero estimates represent non-significant results with significance assumed at $P \leq 0.10$.

In both markets positive and negative cross price elasticities are observed. Given the assumption of rational firms, managers are maximizing profits when they observe positive cross price elasticities for their product. In this fashion price increases made by another processor result in increased demand for own product. In Australia Pace Farms has positioned itself to be sensitive both to private label and generic product but proportionately more sensitive to generic product. Private label has established itself as minimally sensitive to Pace Farms but far more sensitive to generic product, its major volume and highest priced competitor. Conversely generic product has positioned itself to be most sensitive private label. This is an essentially detrimental position given that private label is actively pursuing a price cutting strategy and with a positive cross-price elasticity price cuts by private label rob demand from generic, as a result generic is most sensitive to its biggest competitor. In Canada Lilydale is proportionality more sensitive to the other major branded product, Maple Leaf, than Maple Leaf is to it. They have positioned themselves as the weaker branded product yet charge the highest market price.

When examining negative cross-price elasticities one must revert back to standard micro-economic theory. Theory suggests that cross-price elasticities for substitute goods should be positive. Since products considered in this research are normally considered substitutes we have a violation of expectation and actuality. Goods with negative cross-price elasticities are seen as not competing (not substitutes) and may be considered as gross complements. Therefore products observing this condition assume that consumers will buy some of their competitor's product when their own is purchased. Such is the case for Farm Pride and Pace Farms, Farm Pride and private label, Farm Pride and generic, and Lilydale and generic.

Conclusion

In Australia examination of elasticities reveal Pace Farms to have placed its product in direct competition with competing products. Managers must believe that head-to head competition lessens the likelihood of price cuts by competitors. Converse to this logic private label has readily utilized price cuts to make dramatic market share grabs from largely the highest priced, large volume competitor, generic. Pace Farms likely remains as the industry leading processor because it is also the largest producer of eggs in Australia. The producer to processor vertical integration establishes relationships not illustrated in this model.

In Canada Maple Leaf is illustrated to be a proactive brand seeking to differentiate itself from generic and other brands. Being one of the few brands nationally represented its vegetable grain production and promotion program have actively carved out a market niche allowing it to demand higher prices then generic. Conversely Lilydale a proportionately smaller brand has not established itself well. It displays a positive cross-price elasticity relationship that makes it more sensitive to Maple Leaf than Maple Leaf is to it and a negative cross-price elasticity relationship in which consumers buying Lilydale product are more sensitive to changes in generic prices then when consumers buy generic product and Lilydale prices change. Generic product establishes itself as relatively non-competitive with both Lilydale and Maple Leaf. This is likely the result of their overwhelmingly large market share.

In both markets participant strategic action is a significant determinant of market conduct. We reject Bertrand-Nash behavior and identify Stackelberg leaders for both Australia and Canada. Given the identified market structure the next step in this research is two fold. First, in both Australia and Canada there has been a cry by producers for generic advertising primarily funded through a check-off program. Therefore given the preferred model generic advertising may be simulated to determine return to investment. It may be such that generic advertising increases demand but what portion of the increased demand is returned to producers as profits? Secondly, while we have theoretically and empirically investigated horizontal processor strategic action we have not investigated strategic action of retailers. Given the growing concentration of national retailers this is a vital consideration. For this investigation the biggest challenge is gathering appropriate wholesale data. Only with price information at the retail and wholesale level is it possible to investigate the interaction between processors and retailers in addition to processor-processor interaction. In such a game processor interaction is modeled as a vertical game through retailers rather than a direct horizontal game at the processor level.

Ultimately better understanding of market structure and performance is limited by industry participation. The prevalence of high quality datasets is the next economic challenge.

Appendix

Figure A1: Quarterly Australian Average Egg Prices (1998:2-2002:4)

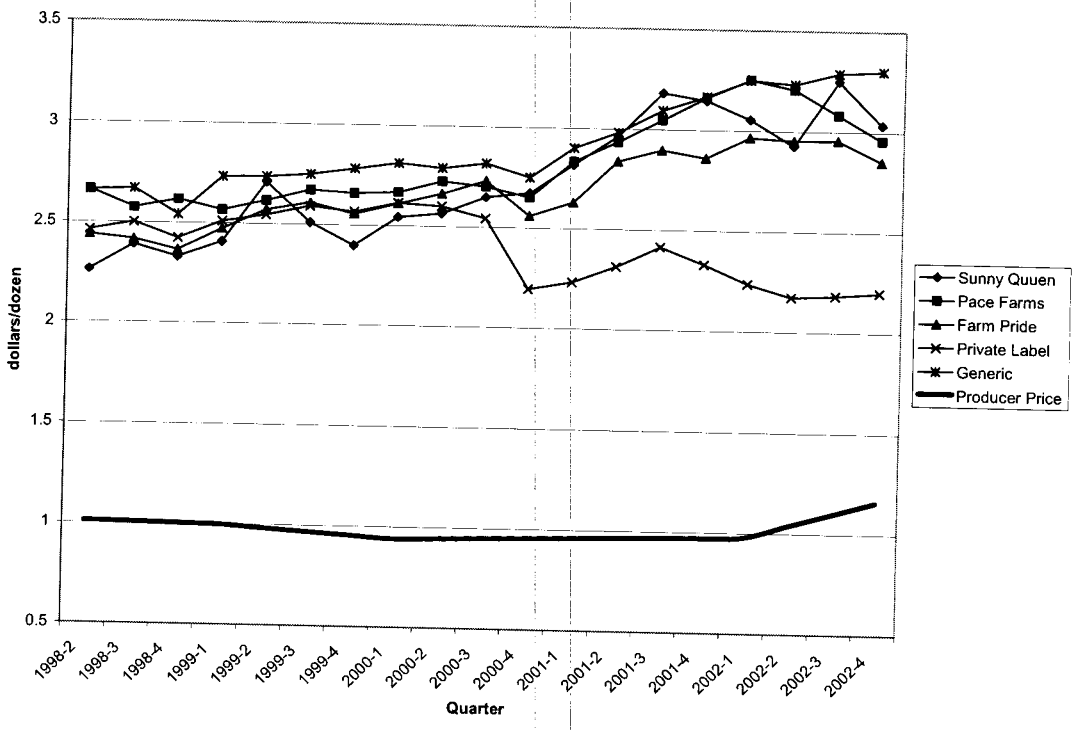


Figure A2: Quarterly Australian Egg Retail Sales by Volume (1998:2-2002:4)

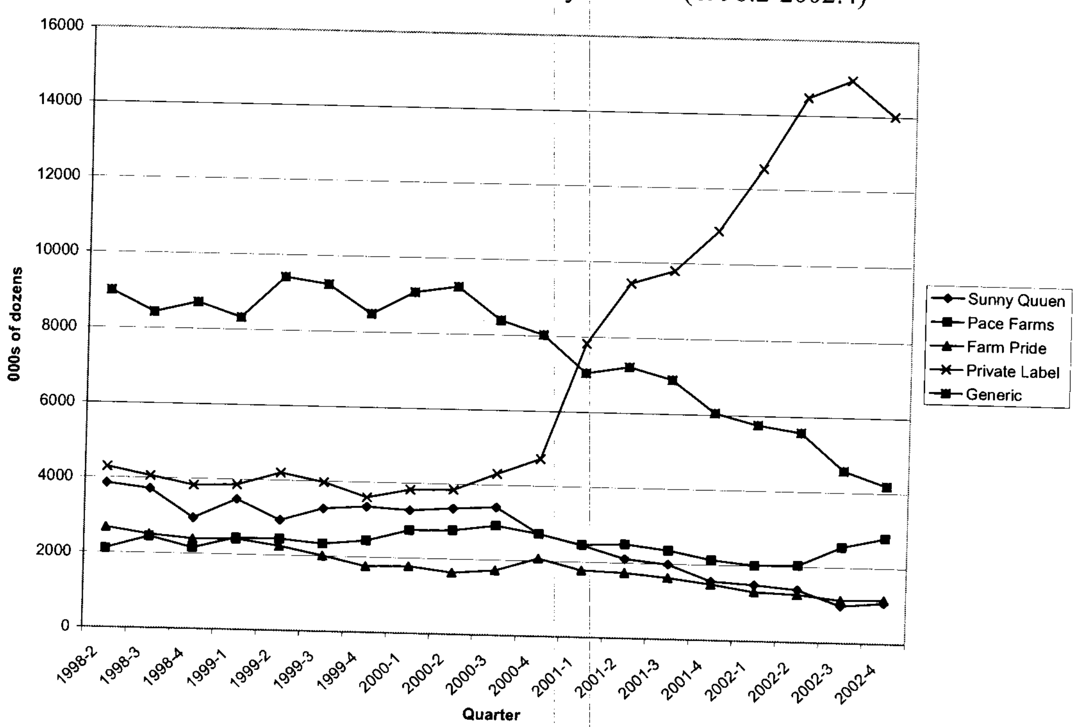


Figure A3: Quarterly Australian Egg Retail Sales by Value (1998:2-2002:4)

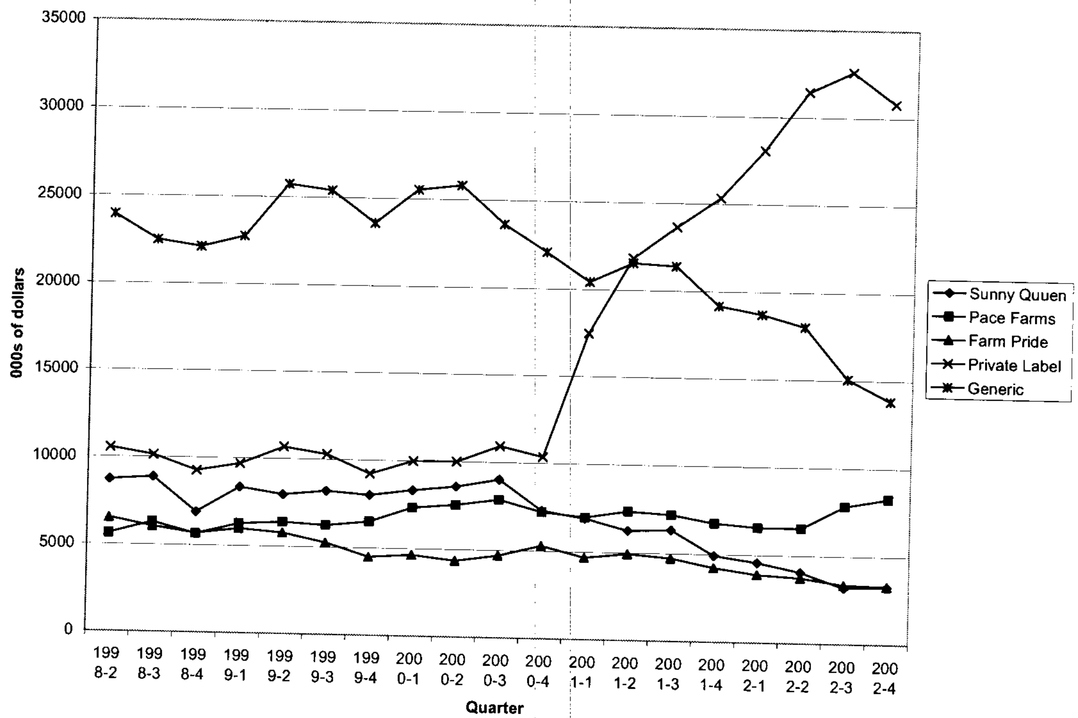


Figure A4: Quarterly Australian Egg Advertising by Brand (1998:2-2002:4)

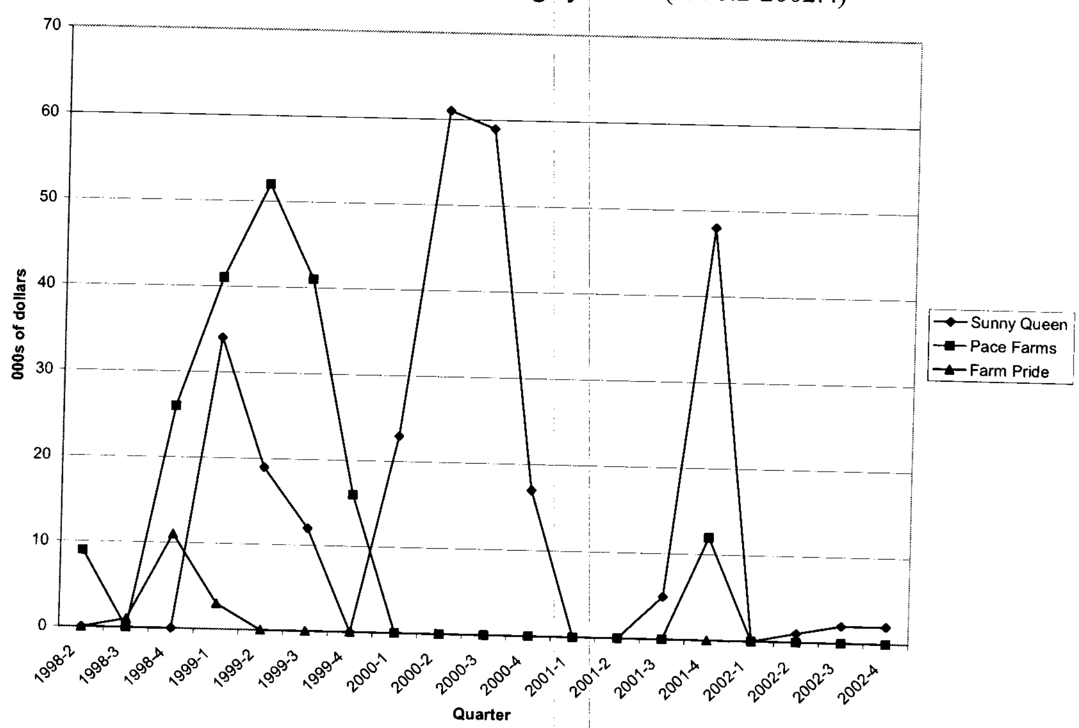


Figure A5: Weekly Canadian Fresh Chicken Retail and Producer Prices (2001:1-2003:44)

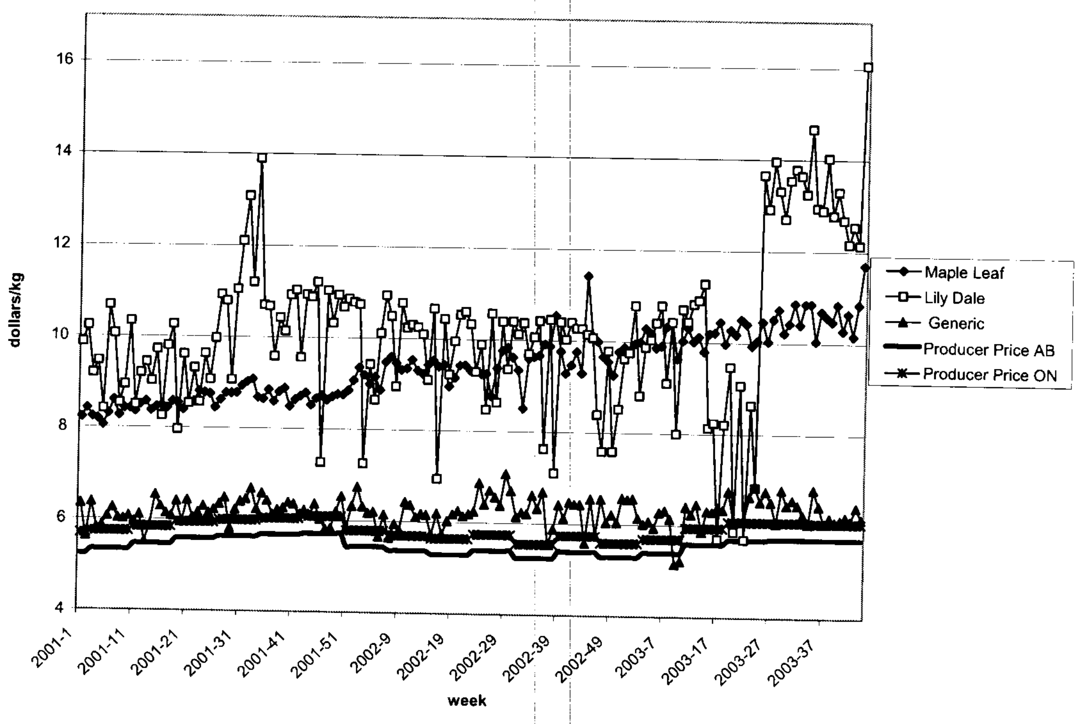


Figure A6: Weekly Canadian Fresh Chicken Retail Sales by Volume (2001:1-2003:44)

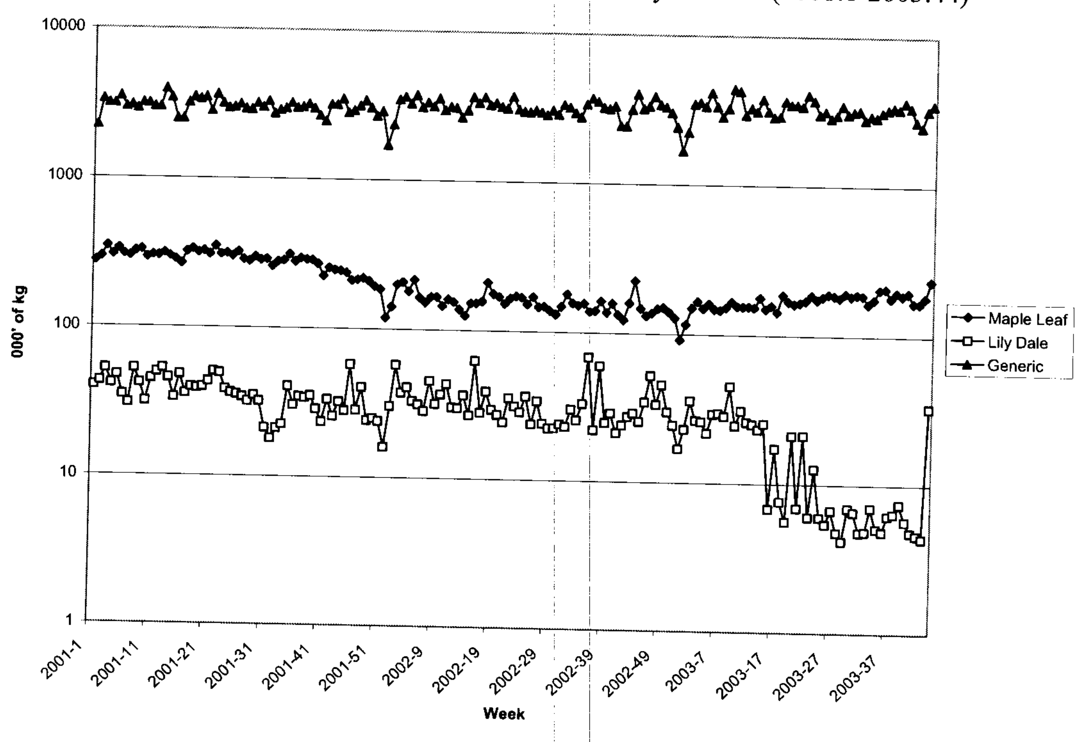


Figure A7: Weekly Canadian Fresh Chicken Retail Sales by Value (2001:1-2003:44)

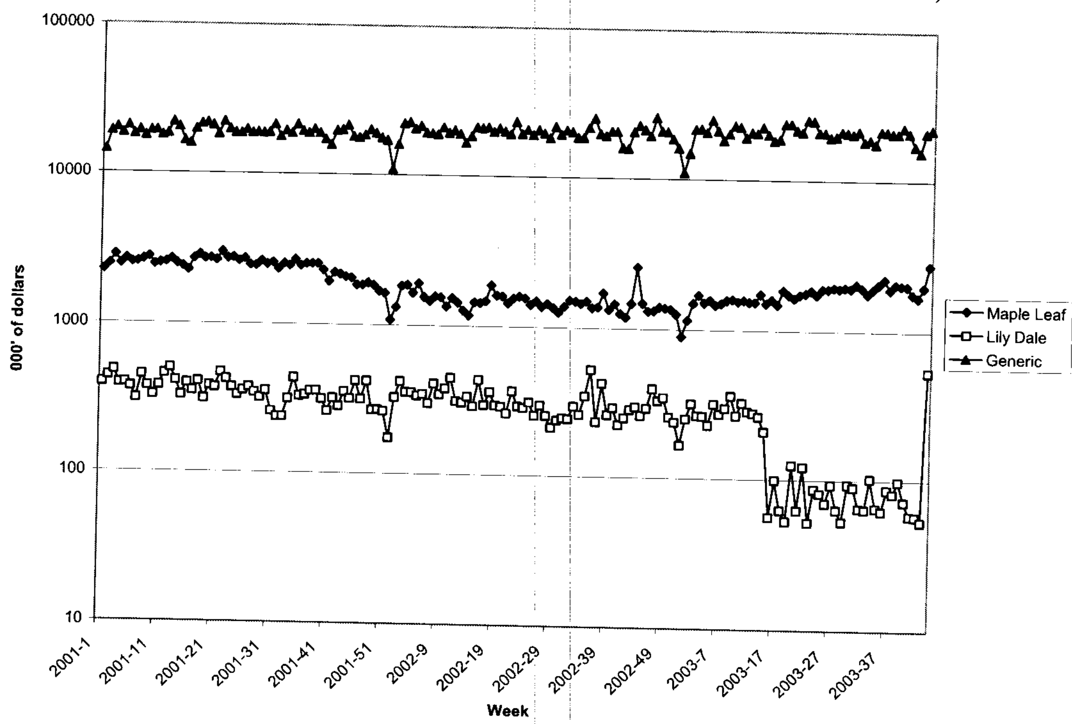


Table A1: Australian egg market: Bertrand model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α1	4.04E+06	1.26E+06	3.20107	[.001]
α2	4.93E+06	709210	6.94793	[.000]
α3	5.54E+06	572650	9.67447	[.000]
α4	-1.46E+07	3.78E+06	-3.85144	[.000]
α5	1.59E+07	2.31E+06	6.89625	[.000]
γ11	-1.71E+08	9.26E+06	-18.4452	[.000]
γ12= γ	-4.88E+06	2.21E+07	-0.2204	[.826]
γ13= γ	6.96E+07	1.84E+07	3.77265	[.000]
γ14= γ	2.38E+07	4.78E+07	0.497545	[.619]
γ15= γ	8.24E+07	5.70E+07	1.44719	[.148]
γ22	-2.65E+08	2.05E+07	-12.9481	[.000]
γ23= γ	-7.41E+07	1.68E+07	-4.40049	[.000]
γ24= γ	1.01E+08	3.31E+07	3.06056	[.002]
γ25= γ	1.20E+08	4.63E+07	2.58079	[.010]
γ33	-1.16E+08	6.76E+06	-17.206	[.000]
γ34= γ	-4.07E+07	2.49E+07	-1.63293	[.102]
γ35= γ	-6.08E+07	3.74E+07	-1.62605	[.104]
γ44	-5.60E+08	2.82E+07	-19.8408	[.000]
γ45= γ	5.07E+08	9.53E+07	5.31339	[.000]
γ55	-1.00E+09	8.77E+07	-11.4513	[.000]
λ11	-7575.35	7699.52	-0.98387	[.325]
λ12	31096	8654.63	3.59299	[.000]
λ13	35705.6	13920.4	2.56499	[.010]
λ21	-2196.92	3700.63	-0.59366	[.553]
λ22	17339.8	4355.41	1.48792	[.136]
λ23	326.835	7029.74	0.046493	[.963]
λ31	-1602.93	3163.56	-0.50669	[.612]
λ32	-4758.21	3673.32	-1.29534	[.195]
λ33	-7603.4	5958.98	-1.27596	[.202]
λ41	29284.7	26962.1	1.08614	[.277]
λ42	-91845.8	30895.8	-2.97276	[.003]
λ43	-196542	46544.1	-4.22271	[.000]
λ51	-16889.4	13771	-1.22645	[.220]
λ52	18520.9	15191.9	1.21913	[.223]
λ53	99890.3	24958.9	4.00219	[.000]
μ11	-169841	28636.3	-5.93096	[.000]
μ21	41691.8	18532.6	2.24965	[.024]
μ31	-86888.4	14398.1	-6.0347	[.000]
μ41	508918	56605.3	8.99064	[.000]
μ51	-191370	53883.3	-3.55156	[.000]
μ21	-8.44E-03	0.018495	-0.45643	[.648]
μ22	-2.14E-03	0.011267	-0.19035	[.849]
μ23	0.029926	9.19E-03	3.25613	[.001]
μ24	0.280489	0.062933	4.45696	[.000]
μ25	0.059628	0.034036	1.75191	[.080]

Table A2: Australian egg market: Stackelberg-Sunny Queen model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α_1	3.93E+06	1.26E+06	3.10703	[.002]
α_2	4.94E+06	710706	6.95373	[.000]
α_3	5.51E+06	574039	9.60202	[.000]
α_4	-1.43E+07	3.79E+06	-3.77682	[.000]
α_5	1.59E+07	2.31E+06	6.88858	[.000]
γ_{11}	-1.80E+08	1.34E+07	-13.4946	[.000]
$\gamma_{12}=\gamma$	-4.39E+06	2.05E+07	-0.21422	[.830]
$\gamma_{13}=\gamma$	7.15E+07	1.71E+07	4.18565	[.000]
$\gamma_{14}=\gamma$	2.28E+07	4.72E+07	0.482073	[.630]
$\gamma_{15}=\gamma$	9.37E+07	5.64E+07	1.66155	[.097]
γ_{22}	-2.65E+08	2.04E+07	-13.005	[.000]
$\gamma_{23}=\gamma$	-7.43E+07	1.69E+07	-4.40518	[.000]
$\gamma_{24}=\gamma$	1.02E+08	3.34E+07	3.06363	[.002]
$\gamma_{25}=\gamma$	1.16E+08	4.65E+07	2.49936	[.012]
γ_{33}	-1.15E+08	6.80E+06	-16.9872	[.000]
$\gamma_{34}=\gamma$	-4.08E+07	2.51E+07	-1.62805	[.104]
$\gamma_{35}=\gamma$	-5.95E+07	3.75E+07	-1.5847	[.113]
γ_{44}	-5.69E+08	3.11E+07	-18.3242	[.000]
$\gamma_{45}=\gamma$	5.06E+08	9.51E+07	5.3149	[.000]
γ_{55}	-1.00E+09	8.70E+07	-11.5518	[.000]
λ_{11}	-7599.16	7691	-0.98806	[.323]
λ_{12}	31580.5	8617.05	3.66488	[.000]
λ_{13}	36144.1	13929.3	2.59482	[.009]
λ_{21}	-2207.38	3727.39	-0.59221	[.554]
λ_{22}	17216.2	4364.5	1.48109	[.136]
λ_{23}	543.695	7079.02	0.076804	[.939]
λ_{31}	-1543.66	3167.93	-0.48728	[.626]
λ_{32}	-4577.26	3660.74	-1.25036	[.211]
λ_{33}	-7788.66	5968.32	-1.305	[.192]
λ_{41}	29020.8	26887.9	1.07933	[.280]
λ_{42}	-93356.3	30795.9	-3.03146	[.002]
λ_{43}	-197733	46411.7	-4.26041	[.000]
λ_{51}	-16749.1	13771.4	-1.21622	[.224]
λ_{52}	18697.2	15168.7	1.23262	[.218]
λ_{53}	99794	24950.4	3.99969	[.000]
μ_{11}	-171022	28366	-6.02914	[.000]
μ_{21}	42053.7	18674.7	2.25191	[.024]
μ_{31}	-87008.7	14432.2	-6.02878	[.000]
μ_{41}	508128	56424	9.00552	[.000]
μ_{51}	-192151	53670.9	-3.58018	[.000]
μ_{21}	-8.03E-03	0.018047	-0.44479	[.656]
μ_{22}	-1.49E-03	0.011105	-0.13455	[.893]
μ_{23}	0.029044	9.07E-03	3.20289	[.001]
μ_{24}	0.280159	0.062704	4.46798	[.000]
μ_{25}	0.057391	0.033875	1.69417	[.090]

Table A3: Australian egg market: Stackelberg-Pace Farms model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α1	3.95E+06	1.26E+06	3.12207	[.002]
α2	4.82E+06	706989	6.81945	[.000]
α3	5.53E+06	561759	9.8524	[.000]
α4	-1.36E+07	3.77E+06	-3.59153	[.000]
α5	1.54E+07	2.29E+06	6.74027	[.000]
γ11	-1.79E+08	1.09E+07	-16.4376	[.000]
γ12= γ	-4.32E+06	2.23E+07	-0.19428	[.846]
γ13= γ	6.81E+07	1.85E+07	3.68926	[.000]
γ14= γ	3.34E+07	4.83E+07	0.692222	[.489]
γ15= γ	8.44E+07	5.71E+07	1.47854	[.139]
γ22	-2.70E+08	1.58E+07	-17.0942	[.000]
γ23= γ	-7.84E+07	1.18E+07	-6.64229	[.000]
γ24= γ	1.20E+08	3.25E+07	3.70113	[.000]
γ25= γ	1.07E+08	4.54E+07	2.35383	[.019]
γ33	-1.22E+08	7.99E+06	-15.3151	[.000]
γ34= γ	-5.53E+07	2.49E+07	-2.2204	[.026]
γ35= γ	-3.15E+07	3.62E+07	-0.86994	[.384]
γ44	-5.68E+08	2.96E+07	-19.1996	[.000]
γ45= γ	4.30E+08	9.55E+07	4.50764	[.000]
γ55	-8.75E+08	8.48E+07	-10.3216	[.000]
λ11	-7478.65	7713.85	-0.96951	[.332]
λ12	31337.6	8668.16	3.61525	[.000]
λ13	35274.1	13955	2.52771	[.011]
λ21	-927.966	3733.38	-0.24856	[.804]
λ22	16395.3	4343.79	1.47868	[.138]
λ23	-1871.95	7110.45	-0.26327	[.792]
λ31	-2189.8	3126.79	-0.70033	[.484]
λ32	-4077.51	3616.8	-1.12738	[.260]
λ33	-5374.07	5954.41	-0.90254	[.367]
λ41	28189.7	26892.4	1.04824	[.295]
λ42	-94334	30813.7	-3.06143	[.002]
λ43	-196729	46422.5	-4.23779	[.000]
λ51	-19488.3	13694.1	-1.42312	[.155]
λ52	23099.5	15080.5	1.53175	[.126]
λ53	108139	24840.8	4.35326	[.000]
µ11	-165984	28838.6	-5.75563	[.000]
µ21	51111.8	18580.7	2.7508	[.006]
µ31	-95018.7	14411.6	-6.59322	[.000]
µ41	509497	56466.5	9.02299	[.000]
µ51	-231350	53749.9	-4.3042	[.000]
µ21	-7.91E-03	0.018563	-0.42601	[.670]
µ22	6.63E-04	0.011293	0.058677	[.953]
µ23	0.028728	9.05E-03	3.17421	[.002]
µ24	0.288937	0.062774	4.60279	[.000]
µ25	0.043131	0.033756	1.27773	[.201]

Table A4: Australian egg market: Stackelberg-Farm Pride model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α1	4.08E+06	1.25E+06	3.25527	[.001]
α2	4.88E+06	705376	6.92019	[.000]
α3	5.58E+06	570932	9.76518	[.000]
α4	-1.45E+07	3.78E+06	-3.84458	[.000]
α5	1.59E+07	2.31E+06	6.9033	[.000]
γ11	-1.70E+08	9.16E+06	-18.6149	[.000]
γ12= γ	-8.39E+06	2.18E+07	-0.38443	[.701]
γ13= γ	7.22E+07	1.79E+07	4.03669	[.000]
γ14= γ	2.11E+07	4.73E+07	0.446876	[.655]
γ15= γ	8.38E+07	5.63E+07	1.48727	[.137]
γ22	-2.64E+08	1.97E+07	-13.3853	[.000]
γ23= γ	-7.39E+07	1.57E+07	-4.72312	[.000]
γ24= γ	1.03E+08	3.24E+07	3.18402	[.001]
γ25= γ	1.20E+08	4.55E+07	2.64651	[.008]
γ33	-1.22E+08	9.90E+06	-12.3487	[.000]
γ34= γ	-4.04E+07	2.45E+07	-1.64511	[.100]
γ35= γ	-6.01E+07	3.69E+07	-1.62828	[.103]
γ44	-5.62E+08	2.85E+07	-19.6939	[.000]
γ45= γ	5.02E+08	9.43E+07	5.32	[.000]
γ55	-9.99E+08	8.48E+07	-11.7823	[.000]
λ11	-7728.19	7646.78	-1.01065	[.312]
λ12	31143.6	8599.9	3.62139	[.000]
λ13	35973.5	13827.2	2.60165	[.009]
λ21	-2104.09	3682.09	-0.57144	[.568]
λ22	17282.9	4331.07	1.49168	[.135]
λ23	345.702	6991.03	0.049449	[.961]
λ31	-1662.3	3157.59	-0.52645	[.599]
λ32	-4725.4	3662.98	-1.29004	[.197]
λ33	-7519.42	5959.05	-1.26185	[.207]
λ41	29337.9	26978.9	1.08744	[.277]
λ42	-92076.4	30914.4	-2.97843	[.003]
λ43	-196107	46576.6	-4.21041	[.000]
λ51	-17062.1	13753.1	-1.2406	[.215]
λ52	18632.7	15152.7	1.22966	[.219]
λ53	99967.8	24898.6	4.015	[.000]
μ11	-171449	28280.5	-6.06242	[.000]
μ21	42607.3	18187.7	2.34265	[.019]
μ31	-87119.9	14196.5	-6.13671	[.000]
μ41	509325	56647.9	8.99106	[.000]
μ51	-193419	53346.1	-3.62574	[.000]
μ21	-8.31E-03	0.018357	-0.45244	[.651]
μ22	-1.70E-03	0.011082	-0.15312	[.878]
μ23	0.030014	8.91E-03	3.36901	[.001]
μ24	0.281946	0.062914	4.48147	[.000]
μ25	0.058315	0.033771	1.72678	[.084]

Table A5: Australian egg market: Stackelberg-Private Label model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha1$	4.18E+06	1.22E+06	3.42728	[.001]
$\alpha2$	4.95E+06	706673	6.99944	[.000]
$\alpha3$	5.53E+06	574584	9.62865	[.000]
$\alpha4$	-1.49E+07	3.58E+06	-4.17845	[.000]
$\alpha5$	1.57E+07	2.29E+06	6.87709	[.000]
$\gamma11$	-1.79E+08	1.21E+07	-14.7743	[.000]
$\gamma12= \gamma$	-207876	2.23E+07	-9.34E-03	[.993]
$\gamma13= \gamma$	6.74E+07	1.86E+07	3.62121	[.000]
$\gamma14= \gamma$	1.48E+07	4.64E+07	0.318557	[.750]
$\gamma15= \gamma$	8.32E+07	5.75E+07	1.44733	[.148]
$\gamma22$	-2.64E+08	1.90E+07	-13.94	[.000]
$\gamma23= \gamma$	-7.41E+07	1.62E+07	-4.56592	[.000]
$\gamma24= \gamma$	1.01E+08	3.32E+07	3.04638	[.002]
$\gamma25= \gamma$	1.15E+08	4.54E+07	2.53958	[.011]
$\gamma33$	-1.19E+08	7.59E+06	-15.7358	[.000]
$\gamma34= \gamma$	-3.87E+07	2.55E+07	-1.52077	[.128]
$\gamma35= \gamma$	-5.95E+07	3.62E+07	-1.64244	[.100]
$\gamma44$	-5.45E+08	3.27E+07	-16.6966	[.000]
$\gamma45= \gamma$	5.28E+08	1.00E+08	5.27772	[.000]
$\gamma55$	-1.01E+09	7.85E+07	-12.9115	[.000]
$\lambda11$	-8259.69	7504.16	-1.10068	[.271]
$\lambda12$	31697.1	8476.84	3.73926	[.000]
$\lambda13$	36191.3	13619	2.6574	[.008]
$\lambda21$	-2393.59	3702.73	-0.64644	[.518]
$\lambda22$	17457.3	4371.93	1.49298	[.135]
$\lambda23$	585.617	7058.76	0.082963	[.934]
$\lambda31$	-1384.25	3187.78	-0.434238	[.664]
$\lambda32$	-4752.27	3699.86	-1.28444	[.199]
$\lambda33$	-8246.45	6018.69	-1.37014	[.171]
$\lambda41$	30574.6	26053.4	1.17354	[.241]
$\lambda42$	-93696	29970.8	-3.12624	[.002]
$\lambda43$	-195024	45190.6	-4.3156	[.000]
$\lambda51$	-15325.7	13889.7	-1.10338	[.270]
$\lambda52$	18266.2	15201.9	1.20158	[.230]
$\lambda53$	95229.6	25343.4	3.75757	[.000]
$\mu11$	-174977	28046.1	-6.23891	[.000]
$\mu21$	40788.6	18588.5	2.19429	[.028]
$\mu31$	-85502.3	14630.7	-5.84404	[.000]
$\mu41$	520173	56608.7	9.18893	[.000]
$\mu51$	-178779	56117.9	-3.18577	[.001]
$\mu21$	-5.72E-03	0.01827	-0.313038	[.754]
$\mu22$	-2.49E-03	0.011316	-0.220067	[.826]
$\mu23$	0.030607	9.28E-03	3.29975	[.001]
$\mu24$	0.275161	0.061121	4.50191	[.000]
$\mu25$	0.059853	0.033917	1.76469	[.078]

Table A6: Australian egg market: Stackelberg-Generic model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α1	5.63E+06	983666	5.72524	[.000]
α2	4.22E+06	637509	6.61847	[.000]
α3	6.10E+06	533658	11.4386	[.000]
α4	-1.76E+07	3.48E+06	-5.05692	[.000]
α5	1.65E+07	1.94E+06	8.51304	[.000]
γ11	-1.70E+08	9.14E+06	-18.5659	[.000]
γ12= γ	1.75E+07	1.82E+07	0.960494	[.337]
γ13= γ	5.03E+07	1.61E+07	3.13164	[.002]
γ14= γ	-2.86E+07	3.61E+07	-0.79098	[.429]
γ15= γ	1.92E+07	4.99E+07	0.384313	[.701]
γ22	-2.56E+08	2.23E+07	-11.4807	[.000]
γ23= γ	-6.78E+07	1.61E+07	-4.21286	[.000]
γ24= γ	7.27E+07	2.24E+07	3.24195	[.001]
γ25= γ	2.06E+08	3.56E+07	5.78445	[.000]
γ33	-1.16E+08	6.73E+06	-17.2549	[.000]
γ34= γ	2.63E+06	1.95E+07	0.13477	[.893]
γ35= γ	-1.75E+08	2.97E+07	-5.89046	[.000]
γ44	-5.67E+08	3.42E+07	-16.5863	[.000]
γ45= γ	7.72E+08	8.65E+07	8.92619	[.000]
γ55	-1.40E+09	1.03E+08	-13.607	[.000]
λ11	-14809.9	6135.34	-2.41387	[.016]
λ12	35693.3	7063.85	5.05296	[.000]
λ13	52793.4	11311.1	4.6674	[.000]
λ21	-4148.7	3604.03	-1.15113	[.250]
λ22	22367.3	4233.82	1.58214	[.114]
λ23	3771.49	6416.47	0.587783	[.557]
λ31	871.524	3193.77	0.272882	[.785]
λ32	-9796.89	3707.97	-2.64211	[.008]
λ33	-13847.1	5706.59	-2.42651	[.015]
λ41	37962.8	25419.8	1.49344	[.135]
λ42	-98526.7	29303	-3.36235	[.001]
λ43	-215018	44403.1	-4.8424	[.000]
λ51	-4353.47	14053	-0.30979	[.757]
λ52	85.4315	15707.5	5.44E-03	[.996]
λ53	65909.9	25671	2.56748	[.010]
μ11	-203006	22250.7	-9.12359	[.000]
μ21	22140.2	14001.9	1.58123	[.114]
μ31	-59693	12195.3	-4.89477	[.000]
μ41	519409	55660.8	9.3317	[.000]
μ51	-45919.1	53589.2	-0.85687	[.392]
μ21	4.26E-03	0.015197	0.280073	[.779]
μ22	-0.023973	0.01041	-2.30294	[.021]
μ23	0.050357	8.98E-03	5.60494	[.000]
μ24	0.25203	0.059321	4.24856	[.000]
μ25	0.126264	0.034039	3.70944	[.000]

Table A8: Canadian fresh chicken market: Bertrand model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α 1	49591.5	10505.5	4.72051	[.000]
α 2	133663	47839.5	2.794	[.005]
α 3	3.73E+06	73629.9	50.6446	[.000]
γ11	-459969	21993.8	-20.9136	[.000]
γ12= γ21	552103	112427	4.91079	[.000]
γ13= γ31	-363153	186908	-1.94295	[.052]
γ22	-1.81E+06	65863.2	-27.4601	[.000]
γ23= γ32	375337	735359	0.510414	[.610]
γ33	-6.91E+07	1.49E+06	-46.4569	[.000]
μ11	-231.651	19.8021	-11.6983	[.000]
μ12	-782.735	60.4507	-12.9483	[.000]
μ31	-504.277	142.177	-3.54683	[.000]
μ21	5.33E-04	2.68E-04	1.98748	[.047]
μ22	9.47E-03	1.08E-03	8.75924	[.000]
μ 23	0.141371	2.05E-03	68.84	[.000]

Table A9: Canadian fresh chicken market: Stackelberg-Lilydale model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α 1	33321.6	9182.36	3.62887	[.000]
α 2	128643	45198.3	2.8462	[.004]
α 3	3.76E+06	73250.8	51.3222	[.000]
γ11	-197439	17974.6	-10.9843	[.000]
γ12= γ21	498492	104563	4.76738	[.000]
γ13= γ31	-596340	155851	-3.82634	[.000]
γ22	-1.86E+06	69854.7	-26.6454	[.000]
γ23= γ32	989017	711467	1.39011	[.164]
γ33	-7.03E+07	1.49E+06	-47.3098	[.000]
μ11	-209.435	17.4325	-12.0141	[.000]
μ12	-861.523	56.8592	-15.1519	[.000]
μ31	-478.344	140.676	-3.40033	[.001]
μ21	9.51E-04	2.16E-04	4.41015	[.000]
μ22	8.86E-03	1.01E-03	8.73725	[.000]
μ 23	0.141551	2.03E-03	69.6365	[.000]

Table A10: Canadian fresh chicken market: Stackelberg-Maple Leaf model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α 1	46303.6	10539.8	4.39319	[.000]
α 2	95782.5	46450.4	2.06204	[.039]
α 3	3.77E+06	72114.1	52.2741	[.000]
γ11	-455102	21583.1	-21.0861	[.000]
γ12= γ21	723534	113315	6.38517	[.000]
γ13= γ31	-520299	186771	-2.78576	[.005]
γ22	-989440	99129	-9.98134	[.000]
γ23= γ32	-631142	705600	-0.89448	[.371]
γ33	-6.77E+07	1.43E+06	-47.4239	[.000]
μ11	-248.05	19.7149	-12.5819	[.000]
μ12	-839.776	57.2124	-14.6782	[.000]
μ31	-470.243	135.847	-3.46157	[.001]
μ21	4.79E-04	2.69E-04	1.77901	[.075]
μ22	0.010161	1.04E-03	9.78104	[.000]
μ 23	0.140326	1.98E-03	71.0362	[.000]

Table A11: Canadian fresh chicken market: Stackelberg-Generic model parameter estimates.

Parameter	Estimate	Error	t-statistic	P-value
α 1	48339.4	10508.2	4.60017	[.000]
α 2	144734	48036.7	3.01299	[.003]
α 3	3.72E+06	73759.4	50.4238	[.000]
γ11	-462893	22200.1	-20.851	[.000]
γ12= γ21	546545	112467	4.8596	[.000]
γ13= γ31	-329439	186940	-1.76227	[.078]
γ22	-1.83E+06	66985.7	-27.3616	[.000]
γ23= γ32	234586	737612	0.318034	[.750]
γ33	-6.88E+07	1.49E+06	-46.1415	[.000]
μ11	-230.894	19.8189	-11.6502	[.000]
μ12	-785.646	60.6449	-12.9549	[.000]
μ31	-481.382	142.652	-3.37453	[.001]
μ21	5.38E-04	2.69E-04	2.00239	[.045]
μ22	9.42E-03	1.08E-03	8.68499	[.000]
μ 23	0.141489	2.06E-03	68.7535	[.000]

Figure A8: Estimation goodness of fit statistics for Australian Eggs: Preferred Model Stackelberg-Pace Farms

```
Demand Equation Q1 (Sunny Queen)
Mean of dep. var. = .252872E+07            Std. error of regression = 209143.
Std. dev. of dep. var. = 912386.           R-squared = .944377
Sum of squared residuals = .787336E+12     LM het. test = .197666 [.657]
Variance of residuals = .437409E+11        Durbin-Watson = 1.35288

Demand Equation Q2 (Pace Farms)
Mean of dep. var. = .246099E+07            Std. error of regression = 70192.6
Std. dev. of dep. var. = 263043.           R-squared = .925667
Sum of squared residuals = .886860E+11     LM het. test = .454332 [.500]
Variance of residuals = .492700E+10        Durbin-Watson = 2.16146

Demand Equation Q3 (Farm Pride)
Mean of dep. var. = .178065E+07            Std. error of regression = 66401.1
Std. dev. of dep. var. = 425554.           R-squared = .974616
Sum of squared residuals = .793640E+11     LM het. test = 1.58718 [.208]
Variance of residuals = .440911E+10        Durbin-Watson = 2.15246

Demand Equation Q4 (Private Label)
Mean of dep. var. = .745226E+07            Std. error of regression = 826349.
Std. dev. of dep. var. = .430239E+07       R-squared = .961960
Sum of squared residuals = .122913E+14     LM het. test = 7.19887 [.007]
Variance of residuals = .682852E+12        Durbin-Watson = .684190

Demand Equation Q5 (Generic)
Mean of dep. var. = .926218E+07            Std. error of regression = 308766.
Std. dev. of dep. var. = .199941E+07       R-squared = .975115
Sum of squared residuals = .171605E+13     LM het. test = 4.03064 [.045]
Variance of residuals = .953363E+11        Durbin-Watson = 1.70052

Price Reaction Equation P1 (Sunny Queen)
Mean of dep. var. = 2.75300                Std. error of regression = .400759
Std. dev. of dep. var. = .302206           R-squared = .589303
Sum of squared residuals = 2.89094         LM het. test = .795261 [.373]
Variance of residuals = .160608            Durbin-Watson = .152861

Price Reaction Equation P2 (Pace Farms)
Mean of dep. var. = 2.82961                Std. error of regression = .233855
Std. dev. of dep. var. = .234578           R-squared = .699167
Sum of squared residuals = .984390         LM het. test = 2.53292 [.111]
Variance of residuals = .054688            Durbin-Watson = .168419

Price Reaction Equation P3 (Farm Pride)
Mean of dep. var. = 2.69461                Std. error of regression = .264068
Std. dev. of dep. var. = .192960           R-squared = .310061
Sum of squared residuals = 1.25518         LM het. test = 7.51653 [.006]
Variance of residuals = .069732            Durbin-Watson = .154441

Price Reaction Equation P4 (Private Label)
Mean of dep. var. = 2.39794                Std. error of regression = .606969
Std. dev. of dep. var. = .165267           R-squared = .575299
Sum of squared residuals = 6.63139         LM het. test = 14.4247 [.000]
Variance of residuals = .368411            Durbin-Watson = .051727

Price Reaction Equation P5 (Generic)
Mean of dep. var. = 2.87743                Std. error of regression = .332014
Std. dev. of dep. var. = .229092           R-squared = .288692
Sum of squared residuals = 1.98420         LM het. test = 1.81544 [.178]
Variance of residuals = .110233            Durbin-Watson = .040941
```

Figure A9: Estimation goodness of fit statistics for Canadian Chicken: Preferred Model Stackelberg-Generic

```
Demand Equation Q1 (Lilydale)
Mean of dep. var. = 28832.9                      Std. error of regression = 8055.14
Std. dev. of dep. var. = 13900.8                 R-squared = .664308
Sum of squared residuals = .960303E+10           LM het. test = 1.38920 [.239]
Variance of residuals = .648853E+08              Durbin-Watson = 1.13995

Demand Equation Q2 (Maple Leaf)
Mean of dep. var. = 204788.                      Std. error of regression = 38820.0
Std. dev. of dep. var. = 65403.1                 R-squared = .663030
Sum of squared residuals = .223034E+12           LM het. test = 9.04434 [.003]
Variance of residuals = .150699E+10              Durbin-Watson = .335105

Demand Equation Q3 (Generic)
Mean of dep. var. = .318400E+07                  Std. error of regression = 69431.4
Std. dev. of dep. var. = 419113.                 R-squared = .972469
Sum of squared residuals = .713467E+12           LM het. test = 3.10340 [.078]
Variance of residuals = .482072E+10              Durbin-Watson = .631949

Price Reaction Equation P1 (Lilydale)
Mean of dep. var. = 10.2035                      Std. error of regression = 2.53720
Std. dev. of dep. var. = 1.77146                 R-squared = .068934
Sum of squared residuals = 952.732               LM het. test = 7.57223 [.006]
Variance of residuals = 6.43738                  Durbin-Watson = .435182

Price Reaction Equation P2 (Maple Leaf)
Mean of dep. var. = 9.43851                      Std. error of regression = 5.19287
Std. dev. of dep. var. = .784188                 R-squared = .380877
Sum of squared residuals = 3990.96               LM het. test = 125.638 [.000]
Variance of residuals = 26.9659                  Durbin-Watson = .030500

Price Reaction Equation P3 (Generic)
Mean of dep. var. = 6.23331                      Std. error of regression = 2.61154
Std. dev. of dep. var. = .311067                 R-squared = .421907E-03
Sum of squared residuals = 1009.38               LM het. test = 74.9565 [.000]
Variance of residuals = 6.82012                  Durbin-Watson = .039898
```

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