University of Alberta

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

by

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Abstract

Given recent increasing concentration in numerous markets, interest in market structure and performance has grown dramatically. In these developing or existing oligopoly markets, theoretical and empirical research largely 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's conduct. Further research has incorporated these aspects when considering returns on investments. The success of public or private investments in advertising, research and development, branding, etc. is shown to be influenced by both market structure and participant conduct.

In this thesis the application of market channel specification and game theory strategic action, as related to the Canadian fresh chicken market and the Australian whole shell egg market, is two fold. Firstly, it is used to empirically investigate processor conduct. In both markets, processors are confronted with a choice between marketing branded products and/or generic products. Additionally, the growth of national retailers has created major store brand competitors. Optimal processor action forces the consideration of all alternatives. Secondly, the empirical estimates are used to develop a synthetic model which analyzes investments in generic advertising and research, as it affects both producers and processors.

In both Canada and Australia, competitive (Bertrand-Nash) behavior is rejected in favor of a market leader (Stackelberg) behavior. In Canada, generic product, with its overwhelming market share, is the Stackelberg leader; while in Australia, Pace Farms, a private brand, is the market leader. Additionally, in Canada it is illustrated that while Lilydale acts as a producer cooperative, other participants still treat them as in investor owned firm. Given these market conditions benefits from generic advertising or research are seen to

favor Canadian generic advertising; Canadian investment in research or Australian investment in generic advertising or research in negative for producers. On the other hand, processors only observe small marginal increases or decreases in returns; no particular incentive for processors to favor investment in generic advertising or research exists.

Analysis in both markets was abstracted from retail level data. As such, only horizontal processor strategic action in a vertical market channel was investigated. The potential to add retailer action dramatically improves the chances for theoretical investigation to concur with actual market structure. As a result, while this research advances the empirical estimation of market conduct in the Canadian fresh chicken and Australia whole egg market, it must be seen only as a preliminary step in developing a fully structural model.

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"If I have seen farther than others, it is because I was standing on the shoulders of giants."

-Sir Isaac Newton

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1.0 Introduction

In the Canadian chicken market, Australian egg market, and various other markets throughout the world, increasing concentration in processing and retailing is becoming a noticeable trend. Additionally, 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 products (where they carry the cost of product development and branding), versus selling 'generic' product to grocery stores. Different grocery chains may have different strategies to pursue for their store shelves, which may involve maintaining a balance between generic, branded, and their own private label products. Processors of significantly different sizes sell to grocery store chains that are national in scope, in an industry with very thin margins. In economic nomenclature, 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 is interesting to examine the outcomes of various strategies followed by a particular processor in light of competing processor and retailer choices. The increasing interactions and strategic planning of processors and retailers are becoming industry defining characteristics and not only affect processors and retailers but also producers and consumers. Ultimately, market intermediaries have an increasing influence on societal welfare.

In the remainder of this chapter, the economic problem is presented, industry overview and structure are described, economic considerations of product development and maintenance are outlined, and economic game theory (as related to a successive oligopoly market channel) is described. Finally, the objectives of the research reported here are outlined.

1.1 Economic Problem

Numerous empirical and theoretical studies, Alemson (1970), Spington and Wernerfelt (1985), Quirmbach (1993) and Symeonidis (2003) to mention a few, illustrate that producer groups, processors/manufactures, and or retailers wishing to maximize returns, can invest in strategies such as research, promotion, and product development. Governments can make public investments in the same. The literature suggests that imperfect competition has an impact on the size and distribution of returns to these private and public investments.

Cotterill (2000) has shown that the types of games being played, not just the existence of imperfect competition, can impact the distribution of benefits/losses through the marketing chain. Further investigation of the structure of the games is necessary if producer groups are to make sensible investment decisions.

1.2 Industry Review: Canadian Chicken

Canada's poultry industry, like its dairy industry, operates under a supply management system. This system arose during the 1960s to reduce the dramatic price swings in dairy, chicken, turkey and eggs that were crippling farm sustainability. Supply management was originally set up by farm groups to address issues of price stability. This initial control system was quickly undermined because production controls could only be imposed at regional or provincial levels. To regulate inter-provincial and international trade and foster stable long-term growth, the federal government became involved, first with the creation of the Canadian Dairy Commission in 1966, and other national marketing boards shortly thereafter (Chicken Farmers of Canada, 2002).

In 1970, supply management further progressed with the passing of the National Farm Products Agencies Act 1970-71-72,c.65,s.1. The act established the National Farm Products Marketing Council and authorized the establishment of national marketing agencies for farm products. (Agriculture and Agri-foods Canada). In 1978, the Chicken Farmers of Canada (CFC) was formed under the Farm Products Marketing Agency Act, and through an agreement of the federal government, provincial government, and chicken farmers (i.e. the Federal-Provincial Agreement for Chicken) was given the authority to regulate chicken production in Canada under a system of supply management (CFC, 2000). Additionally, the Federal Provincial Agreement for Chicken formalized provincial institutions that control provincial poultry production. Federal and provincial association relationships are maintained by the National Allocation Agreement which sets national production and specifies provincial quota allocation (CFC, 1998). Provincial allocations and restrictions on inter-provincial trade segregate a national market into provincial arenas. For example, market demand for any one area must be satisfied by primary production in that area; however, chicken production from one area does not need to be consumed or sold into that area. This means that while farm production in a particular area must satisfy demand, finished product may be exported or imported to that area to satisfy final consumption. In this fashion, producer participation is restricted to maintain prices and poultry supply, while creating flexibility in the marketing channel for processors and retailers to determine their own optimal strategies.

Canada's poultry processing industry is becoming increasingly concentrated. As of December 1998 there were 135 primary processing plants (63 federally inspected and 72 provincially inspected). Of these 135 plants the five largest companies: Flamingo Foods, Groupe Dorchester/St. Damase, Lilydale Poultry Cooperative, Maple Leaf Poultry, and Maple Lodge Farms, account for 58% of the poultry processed in Canada. Maple Leaf is considered the single largest firm. When considering chicken slaugthering plants 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 slaughtering in Canada is done by ten companies (Agriculture and Agri-foods Canada). It is apparent that a few large companies control poultry processing in Canada. However, it is note worthy that the list of industries leaders includes three producer cooperatives, Lilydale Poultry Cooperative, Flamingo Foods (owned by Coop Fédère) and Groupe Dorchester/St. Damase. Therefore, the poultry processing sector is not only characterized by increasing concentration, but also by organizations with different organizational structures, investor owned firms (IOFs) and producer cooperatives.

The importance of differentiating between IOFs and producer cooperatives is derived from their unique objective functions. In the long run, an IOF seeks to maximize profit while producer cooperatives intend to maximize cooperative profit and producer surplus. The variation in objective functions has numerous implications for pursuing optimal strategies in pricing and advertising.

The grocery retail industry, like the poultry processing industry, is becoming increasingly concentrated. The growth of national retailers such as Sobeys and Loblaws, at the expense of regional or independent retailers, has created immense opportunity for the creation of market power. Unlike the processing sector, the retail sector is not marked by major cooperative movements.

In Canada chicken has traditionally been sold in a number of forms: generic (fresh or frozen), whole chickens or chicken parts (purchased by retailer butchers with no distinguishing characteristics from one grocery store to another), and branded processed products (two of which are Maple Leaf Naturally Prime and Lilydale Gold). Recently the major rational processor, Maple Leaf, has been aggressively pursuing a strategy of 'branding' fresh product (Naturally Prime) based on production attributes and identifying labels. Grocery store chains faced with the possibility of proliferation of branded fresh products, and additional costs associated, must make decisions about pricing generic product, from whom to purchase it, whether to stock one or more brands, and what markup to assign. The proliferation of brands may affect stocking decisions on processed branded products due to consumer substitution possibilities. Other processors in the chicken industry are faced with making strategic decisions of whether to brand their product or continue providing store generic product.

1.3 Industry Review: Australian Eggs

In comparison to the Canadian industry, the Australia the egg industry has in the past followed a demand/supply system very similar to the dairy and poultry supply management system in Canada. In the late 1930s and early 1940s statutory agreements and acts invoked demand/supply systems in all states and during the 1970s various states enacted quotas to restrict production and support prices. However, during the late 1980s the industry was deregulated following three Australian legislative changes. These legislative changes (as highlighted by the Department of Agriculture, Government of Western Australia (2002)) include:

> *National Competition Policy*: Requires all states to review all legislation and remove anit-competitive laws and regulations.
>
> *Mutual Recognition*: Requires product standards and grades acceptable in any state to be allowed and recognized in all other states.
>
> *Trade Practices Act*: Scrutinizes business and markets and can penalize any practice that restricts competition or is perceived as collusion in the market place.

These legislative changes paved the way for a non-statutory, deregulated environment in most states. At present, only Western Australia fully retains statutory control. Tasmania currently has a legislated license and quota regime, but is currently in parliamentary process to fully deregulate its egg industry. New South Wales, Victoria, Queensland, South Australia, the Capital Territory, and the Northern Territory operate in fully deregulated environments. In many of these states the deregulation process had industry control fall first to cooperatives, which then converted to private companies. Such is the case with Farm Pride Foods and may happen to the state owned and controlled Golden Eggs Farms in Western Australia.

The deregulation in the Australian egg industry has resulted in increased market concentration in producer, and processor market segments. 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) (Western Australia Department of Agriculture, 2002). The increased concentration in the processor markets has been driven by a national retailer presence. Currently, three large supermarket chains, Coles/Newmart, Woolworths, and the Foodland group, control two thirds of the shell egg market. These large supermarket chains at present are seeking national supply agreements. To manage national tenders, many processors are attempting mergers in order to create a national presence. Additionally, processors are progressing heavily in the broken shell, a highly processed egg market, to maintain profitability margins. Consequently, both processor and retail intermediaries are marked with increasing concentration.

In Australia, eggs were traditionally sold in grocery stores as branded products. Each state marketing authority had developed brands of eggs which they promoted. In certain cases, private processors (i.e. Pace Farms) also pursued branding strategies. Consumers were faced with a variety of branded egg products in grocery stores. Since deregulation and increasing concentration in the retail sector, grocery store chains have been pursing strategies of private label or store brand eggs. Store brand eggs now represent 60% by volume of all shell eggs sold, an increase of 40% from the second quarter of 1998.

1.4 Industry Review: Summary

In both Canada and Australia increasingly concentrated processors and retailers are making strategic decisions on sales of generic, branded and private label product. These decisions influence on the quantities and prices of farm products and retail products. The structure of the market also impacts private/public returns to product development, research, and promotion. Effective producer strategies cannot be developed without more clarification of the market structure and market environment.

1.5 Theory and Market Structure

Increasing concentration and possibly market power exploitation mark both Canadian and Australian industries. Cotterill (2000) and Tirtha and Cotterill (2002) describe a similar US market as a "tight oligopoly in successive stages of a market channel." This description deviates from the conventional assumptions of competitive firms and single stage marketing channels to incorporate a more disaggregated model, a two stage industry market channel, and model retailer and processor actions with the possibility of non-competitive behavior. The deviation away from competitive firms with a small number of firms often incorporates models of noncooperative oligopoly (Carlton and Perloff, 2000). In such a model, oligopolists cannot ignore the actions of other firms. In the extremes, a monopolist firm has no rivals, while individual competitive firms are too small to affect the industry's price; therefore each firm reasonably ignores the actions of any other firm. Thus, only the industries collective actions matter. Differing from a monopolist and perfect competition, an oligopolistic firm realizes that the actions of other firms affect its own best policy. The optimal policy or action of the oligopolist is dependent upon the actions of other firms.

Conventional noncooperative models can be illustrated as examples of *game theory* (von Neuman and Morgenstern, 1944). Game theory uses formal models to analyze conflict and interaction between players. Carlton and Perloff (2000) describe games as

> any competition in which strategic behavior is important. Each firm forms a strategy or battle plan of the action it will take (such as set the prices it will set) to compete with other firms. Each firm's payoff (the reward received at the end of the game, profits) depends on the actions of all the firms.

Therefore, the actions and strategies of processors and retailers in the Canadian and Australian industries can be modeled in the context of games and noncooperative oligopolies.

1.6 Research Objectives

The initial objective of this research is to empirically examine the market structure of the Canadian chicken and Australian egg markets. This objective includes modeling of demand and processor strategic conduct for individual products competing in an oligopoly market. This empirical assessment of the market structure is then used to create a synthetic model. The synthetic model analyzes the size and distribution of benefits from producer investments in advertising and research under the existing market structure and conditions.

The remainder of this thesis is organized as follows: Chapter 2 reviews previous work and thought as related to market structure, participant conduct, brand development, advertising and research and development; Chapter 3 presents the structure and intent of the oligopoly model estimated in this research; Chapter 4 illustrates the empirical estimation of the model presented in Chapter 3; Chapter 5 uses the empirical estimates to create a synthetic model for investigation of returns to generic advertising or research; Chapter 6 presents the conclusions and suggestions for further research.

2.0 Previous Theory and Research: Literature Review

In this chapter the various forms of marketplace competition are presented to illustrate the noncooperative oligopoly nature of the Canadian and Australian markets. Given this structure, economic game theory is used to illustrate the possible strategic decisions and actions processors and retailers may pursue. These strategic decisions are further illustrated through discussion of production differentiation, product brand, and advertising. Lastly, a short theoretical section on returns to research and development is presented. Quite often, investment in research is seen as an alternative to investment in advertising and as such requires exploration.

2.1 Forms and Models of Market Competition

Markets can be characterized by a variety of structures and models. At the extremes of the spectrum, we have perfect competition and monopolies. Between these two we find monopolistic competition, which lies closer to perfect competition, and oligopolies, which lie between monopolies and monopolistic competition. The differences and key characteristics of these forms of competition are highlighted in Appendix 1 Table A1. Key characteristics to note include: the number of buyers and sellers, type of product (either homogeneous or heterogeneous) and conditions of entry. In perfect competition, buyers and sellers are numerous, neither are large compared to the relative size of the market, products are homogeneous and entry in the market is free. In a monopoly, buyers are numerous; there is only one seller; there is no close substitute for the product, and market entry is blocked. For a monopolist the ability to be the sole provider of a product creates immense opportunity to exert market power and increase price above the socially optimum level where marginal cost of production equals marginal revenue of retail. Monopolistic competition and oligopolies differ from perfect competition and monopolies primarily in the number of sellers and type of product. In monopolistic competition, while there still are numerous sellers (none of which are large relative to the market), products are heterogeneous/differentiated. In such a market the ability of a seller to differentiate its product from that of a competitor's, imperfect substitutes, allows that seller to demand market premiums. Using a classic example, shoe companies all sell foot wear, yet consumers do not consider all shoes equivalent. Through advertising, product improvements/variations, etc. sport shoes made by Nike are not the same as those from Rebok, dress shoes from Doc Martin are not the same as those from Aldo, and so on and so forth. A key assumption of monopolistic competition is that sellers are numerous. Therefore, they may only have a slight ability to price discriminate. In an oligopoly products may be homogenous or heterogeneous, barriers to entry may or may not exist, but there are only a few sellers. The key difference, few sellers each large relative to the market, is a defining characteristic because the actions of each seller has market implications for the entire market. Knowing that one's own action, or the actions of others can directly affect market conditions, sellers must strategically plan to optimize profits.

While it is rare that true monopolies or perfect competition ever exist, numerous examples of monopolistic competition and oligopoly markets exist. Katz and Rosen (1998) provide a few oligopoly examples:

Table 1: Examples of Oligopolistic Industries.

Industry	Leading Producers	Combined Market Share
Cold cereals sold in the US	Kellogg's, General Mills, Post	75%
Commercial Airliners worldwide	Boeing, Airbus, McDonnell Douglas	94%
Heavy trucks sold in the US	Freightliner, Paccar, Navistar, Volvo GM, Mack Trucks	90%
Pasta sold in the US	Borden, Hershey, CPC International	60%
PC severs worldwide	Compaq, IBM, Hewlett-Packard	60%
Sports drinks sold in the US	Quaker, PepsiCo, Coca-Cola	96%

In the Canadian chicken meat and Australian egg markets, an oligopolistic structure readily defines the processing and retail sector. The markets are vertical in nature and can be described as an oligopoly in successive stages. There are numerous producers, selling to few processors, who sell to few retailers, who sell to many consumers. The limited number of processors and retailers, each of which can influence market conditions, forces participants to strategically plan their actions and anticipate the actions of others. This strategic behavior is referred to as *Game Theory.*

2.2 Game Theory

The formalization of the term *Game Theory* was first described by John von Neuman and Oskar Morgenstern, in their 1944 book *Theory of Games and Economic Behavior*. Dimand and Dimand (1996) note that Game Theory defines an economic concentration that had been developing for 200 years before the phenomenon was named. While various definitions of Game Theory exist, primary elements as suggested by von Neuman and Morgenstern (1944) and others, remain constant in all definitions.

> "Game theory is concerned with how individuals make decisions [to optimize their payoff] when they are aware that their actions affect each other[s' payoff] and when individuals take this into account. It is the interaction among individual decision makers, all of whom are behaving purposefully, [rationally], and whose decisions have implications for other people that makes strategic decisions different from other decisions." (Bierman and Fernandez, 1998)

In such definitions Friedman (1990) suggests three unifying rules of games. First, games have rules that describe the array of allowed action, govern the order in which actions many proceed, and define how each action is related to the outcome of the game. Second, two or more players are involved, each of whom is trying to maximize their objective. Third, each player's outcome/payoff depends on the actions of others thereby forcing an intelligent assessment of the actions likely to be taken by others when considering one's own best action.

These rules allow us to further justify our focus on noncooperative or oligopolistic games. According to rule three, the actions of one player affect the payoffs of other player(s). Therefore monopoly, monopolistic competition, and perfect competition models are unsuitable. Monopolies only have one seller (monopolists actions are not affected by others) and monopolistic competition and perfect competition have too many sellers, none of which are large enough relative to the market for any one seller to affect the payoffs of others. By deductive reasoning we are left solely with oligopolies.

Within an oligopolistic structure two types of interaction among players exists: cooperative and noncooperative (Friedman, 1990; Bierman and Fernandez, 1998;Katz and Rosen, 1998; Docker et al, 2000). Cooperative games often are covered in the literature under cartels or collusion. Essentially, firms make a binding arrangement to collude and exert monopoly power. The incentives behind collusion and cartels are strong. The greater the ability to control market supply, the greater the ability of participants to price discriminate and exert market power to increase returns. However, as the rules of the game dictate, most countries, including Canada and Australia, have rules against collusion and monopolies, thus making cooperative action difficult and illegal (Friedman, 1990). Additionally, Katz and Rosen (1998) illustrate that there are strong incentives for players to cheat or go against the agreement, to increase their own returns at the expense of other members (Appendix 2, Figure A1). Hence collusive agreements and cartels have an inherent element of self-destruction. Again applying deductive reasoning eliminates cooperative games and leaves only noncooperative games.

As Docker et al (2000) suggest, noncooperative games exist when there is a limited number of participants and institutional barriers prevent players from forming binding agreements. Players pay no attention to the fortunes of other players, but realize that the actions of their competitors affect their own best action/response. Noncooperative game theory presents a formal methodology to address strategic uncertainty and to predict the actions of rational players trying to maximize their own payoff.

2.3 Noncooperative Game Theory

The literature on noncooperative game theory is rife with variations of methodology. At the very heart of these methods, is one equilibrium concept, Nash Equilibrium, and three single period oligopoly models, the Cournot model, the Bertrand model, and the Stackleberg/leader-follower model. It is upon these building blocks that the preponderance of noncooperative game theory stands.

To illustrate these concepts, normal-form representation will be used (Gibbons, 1992). Normal form representation uses rules similar to those suggested by Freidman (1990) to transform informal problem statements into appropriate models. Normal-form games consist of the following attributes: (1) the players in the game, (2) the strategies available to each player, and (3) the payoff received by each player based on the combination of strategies played.

In a normal-form n-player game, one to n players exist where by convention any particular player can be referred to as player i. The entire set of strategies available to player i define player i's strategy space. Let S_i denote i's strategy space. Additionally let s_i denote an arbitrary member of S_i i.e.($s_i \in S_i$). That is to say s_i is an individual strategy available to player i. An entire combination set of strategies, one for each player, is represented as (s_1,..s_n). Let u_i denote player i's payoff function where $u_i(s_1,\ldots s_n)$ denotes player i's payoff function given that other player's play strategies $s_1,\ldots s_{i-1},s_{i+1},\ldots s_n$. Therefore the normal-form representation of an n-player games specifies the players' strategy spaces $S_1,..S_n$ and their payoff functions $u_1,..u_n$. We denote this game by G={ $S_1,..S_n$; $u_1,..u_n$) (Gibbons, 1992).

2.3.1 Nash Equilibrium

The Nash equilibrium, based of John F. Nash's 1950 paper "Equilibrium Points in n-player Games, illustrates an equilibrium concept first utilized by Augustin Cournot in 1838. For this reason it is sometimes referred to as the Cournot-Nash Equilibrium. A Nash equilibrium illustrates that a set of strategies is in equilibrium if holding the strategies of all other players constant, no other player can obtain a higher payoff (profit) by choosing a different strategy (Carlton and Perloff, 2000). This concept, while originally developed for finite games (games with a finite number of pure strategies), can be generalized for a variety of applications and applied to a variety of economic and political applications (Freidman, 1990). While many formal definitions of Nash equilibrium exist, in order to keep notation similar here is one offered by Gibbons (1992):

> In the n-player normal-form game, G={$S_1,..S_n$; $u_1,..u_n$), the strategies ($s_1^*,\ldots,s_n^*$) are a Nash Equilibrium if, for each player i, s_i^* is (at least tied for) player i's best response to the strategies specified for the n-1 players, ($s_1^*,\ldots s_{i-1}^*,s_{i+1}^*,\ldots s_n^*$):
>
> $$u_i(s_1^*,\ldots s_{i-1}^*,s_i^*,s_{i+1}^*,\ldots s_n^*) \geq u_i(s_1^*,\ldots s_{i-1}^*,s_i,s_{i+1}^*,\ldots s_n^*)$$
>
> for every feasible strategy s_i in S_i; that is s_i^* solves

$$\max_{s_i \in S_i} u_i(s_1^*,\ldots s_{i-1}^*, s_i, s_{i+1}^*,\ldots s_n^*)$$

In this definition, the predicted strategy of each player is that player's best response to the predicted strategies of the other players. Because no rational player wants to deviate from his or her predicted strategy, such a prediction could be called strategically stable or self-enforcing.

Examples of the Nash Equilibrium concept are readily available for quantity (Cournot) games and price (Bertrand) games. If we imagine an industry with two firms playing quantity games, market equilibrium is said to be Nash in quantities if given that firm 1 sells q1 tickets, firm 2's profit is maximized by selling q2 tickets and given that firm 2 sells q2 tickets, firm 1's profit is maximized by selling q1 tickets. Neither firm can achieve a better payoff by selling quantities of tickets other than q1 and q2. In a price game market equilibrium is said to be Nash in prices if given that firm 1 charges p1 per ticket firm 2 maximizes its profit by charging p2 and given that firm 2 charges p2 per ticket firm 1 maximizes its profit by charging p1 (Katz and Rosen, 1998). These concepts are central to deriving non-cooperative market equilibrium conditions.

2.3.2 Cournot Games

Cournot (quantity) games as illustrated by Bierman and Fernandez (1998), Carlton and Perloff (2000), Dimand and Dimand (1996), Docker, et al (2000), (1998), Friedman (1990),Katz and Rosen (1998), Gibbons (1992) and many others, illustrate a game where each firms' strategy consists of its choice of output level. While it is possible to illustrate an n-player Cournot game a Cournot duopoly is chosen for ease of illustration. In this model, firm1 and firm 2 market homogeneous goods (q_1 & q_2), total market supply Q equals q_1+q_2, market demand is linear Q(P)=a-P, market clearing price is the inverse demand function P(Q)=a-Q where P(Q)=a-Q for Q< a and P(Q) = 0 for Q $\geq$a, and total cost for firm i is $Ci(q_i) = cq_i$ where c is marginal cost and there are no fixed costs. The strategies available to each player are the different quantities, q_1 and q_2. A typical strategy s_i is a quantity choice $q_i \geq 0$ where a firm's strategy space is defined as $S_i[0,\infty]$ because P(Q) = 0 for Q $\geq$a, $s_i = q_i > a$ is not a strategy pursued by either firm. In the duopoly case, the quantity pair (q_i^*, q_j^*) is in Nash equilibrium if for every firm i, q_i^* solves the maximization of the payoff function.

$$\max_{0\le q_i<\infty} \pi_i(q_i^*, q_j^*) = \max_{0\le q_i<\infty} q_i[a-(q_i+q_j^*)-c] \tag{2.1}$$

First order conditions for firm *i*'s optimization problem are both a necessary and sufficient conditions (Gibbons, 1992).

$$^{1}q_i = \frac{1}{2}(a - q_j^* - c) \tag{2.2}$$

Thus, if the pair (q_1^*,q_2^*) is to be in Nash equilibrium the firms' quantity choices must satisfy

$$q_1^* = \frac{1}{2}(a - q_2^* - c) = R_1(q_2) \tag{2.3 a}$$

$$q_2^* = \frac{1}{2}(a - q_1^* - c) = R_2(q_1) \tag{2.3 b}$$

Equations 2.3a and 2.3b illustrate that either firm's optimal output choice is a function of the other firm's output choice. These relationships are modeled in reaction equations $R_1(q_2)$ and $R_2(q_1)$; firm one's (two's) optimal output decision is a function of firm two's (one's) output choice. Solving these two equations and two unknowns for Nash equilibrium conditions we get

$$^{2}q_1^* = q_2^* = \frac{a-c}{3} \tag{2.4}$$

Appendix 2, Figure A2 graphically illustrates the above condition.

2.3.3 Bertrand Games

The first major criticism to Cournot's theory came in 1883, by Joseph Bertrand. Bertrand augured, that in oligopolistic market, if the firms do not set prices it is difficult to determine who does. Cournot's quantity setting strategy fails to explicitly determine the pricing mechanism (Carlton and Perloff, 2000). Bertrand hypothesized that firms set prices rather than quantities.

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[1] Assumes q_j<a-c. This will be proven later.

[2] This illustrates that $q_1^*=q_2^*=(a-c)/3<a-c$.

In Bertrand's model, as illustrated by Bierman and Fernandez (1998), Carlton and Perloff (2000), and Katz and Rosen (1998), firms set prices rather than output. With the assumption that products in a market are homogeneous and consumers have complete information consumers will buy the least expensive product. Each firm assumes that the price of other firm(s) is fixed and that by charging a price just less than the competitor's, the firm is able to capture the entire market. Figure A3 (Appendix 2) illustrates a firm's residual demand curve in a duopoly under Bertrand price competition. Since all firms realize that slightly under cutting their competition will allow them to capture the entire market, the under cutting procedure will continue until no economic profits are attained; marginal cost equal to demand. If all firms have similar and constant marginal cost with no fixed cost the market price will equal marginal cost and no firm will receive economic profits (Simon, 1984). This market equilibrium is the same as the socially optimum, competitive market equilibrium solution, both of which are Nash.

While Bertrand's model is more attractive to some economists because it explains the pricing mechanism neglected in Cournot's theory, the theory itself seems counterintuitive. Theoretically, in Bertrand's model even with two firms market price will equal the competitive market equilibrium, price equals marginal cost. In an oligopoly, it seems unreasonable that few firms will neglect the use of market power to achieve the socially optimal equilibrium. In reality this condition is not readily observed and has been marked as the "Bertrand Paradox" (Dufwenberg and Gneezy, 2000). The Bertrand Paradox, while being a criticized weakness of the Bertrand model, can be alleviated if the assumption of constant returns to scale is relaxed, if goods are not homogeneous, if capacity constraints are introduced, or if firms compete repeatedly in a mega-game (Edgeworth, 1925; Friedman, 1977; Hotelling, 1929; Kreps and Scheeinkman, 1983). Because of its pertinence to the latter portion of this research, the following example illustrates how prices can deviate from the competitive equilibrium in a Bertrand model with heterogeneous goods.

In a simple duopoly example with heterogeneous products, let the demand facing either firm be:

$$q_1(p_1, p_2) = a_0 - a_1 p_1 - a_2 p_2 \tag{2.5 a}$$

$$q_2(p_1, p_2) = b_0 - a_2 p_1 - b_2 p_2 \tag{2.5 b}$$

In this system of demand equations homogeneity of degree one in prices is imposed, symmetry is imposed, demand is a function of prices and exogenous consumption, and price coefficients illustrate own-price and cross-price substitution effects. As a matter of strategy either firm may set any nonnegative price, S_i=[0,∞], and a typical strategy s_i is now a price choice, $p_i \geq 0$. The payoff function for either firm is equal to that firm's profit function:

$$\pi_1(p_1, p_2) = q_1(p_1, p_2)[p_1 - c] = [a_0 - a_1 p_1 - a_2 p_2][p_1 - c]] \qquad (2.6\text{ a})$$

$$\pi_2(p_1, p_2) = q_2(p_1, p_2)[p_2 - c] = [b_0 - a_2 p_1 - b_2 p_2][p_2 - c] \qquad (2.6\text{ b})$$

For the pair (p_1^*,p_2^*) to be in Nash equilibrium $p_1^*$and p_2^* solve

$$\max_{0 \leq p_1 < \infty} \pi_2(p_1, p_2^*) = q_1(p_1, p_2^*)[p_1 - c] = [a_0 - a_1 p_1 - a_2 p_2^*][p_1 - c] \qquad (2.7\text{ a})$$

$$\max_{0 \leq p_2 < \infty} \pi_2(p_1^*, p_2) = q_2(p_!^*, p_2)[p_2 - c] = [b_0 - a_2 p_1^* - b_2 p_2][p_2 - c] \qquad (2.7\text{ b})$$

The solutions to these optimization problems are

$$p_1^* = \frac{-a_0 - a_1 c + a_2 p_2^*}{2a_1} = R_1(q_2) \qquad (2.8\text{ a})$$

$$p_2^* = \frac{-b_0 - b_2 c + a_2 p_1^*}{2b_2} = R_2(q_1) \qquad (2.8\text{ b})$$

Similar to equations 2.3a and 2.b equations 2.12 and 2.13 are price reaction functions; $R_1(p_2)$ and $R_2(p_1)$. Solving these two equations for equilibrium conditions we get

$$p_1^* = -\frac{a_2 b_0 - 2a_0 b_2 - 2a_1 b_2 c + a_2 b_2 c}{-a_2^2 + 4a_1 b_2} \qquad (2.9\text{ a})$$

$$p_2^* = -\frac{a_0 a_2 - 2a_1 b_0 - 2a_1 b_2 c - a_1 a_2 c}{-a_2^2 + 4a_1 b_2} \qquad (2.9\text{ b})$$

In this example, prices (p_1^*, p_2^*) are a function of demand parameters and marginal cost. With no capacity constraints, the degree to which these products are differentiated from one another (i.e. the difference in demand parameters) determines if prices will differ form the Bertrand homogeneous product example, $p=c$.

2.3.4 Stackelberg/Leader Follower Games

In 1934 Heinrich von Stackelberg presented a dynamic model of a duopoly in which a dominant (or leader) firm moves first and a subordinate (or follower) firm moves second (Gibbons, 1992). Stackelberg proposed that in industry and his model the leader first picks its output level and then the other firms are free to choose their optimal output level given their knowledge of the leader firm's choice. However, the leader firm knows that the follower firms will incorporate its quantity decision into their optimal choice and therefore accounts for this in their output choice. This market relationship has been exhibited at some points in the US automotive industry where Ford and Chrysler have made decisions after observing the direction of General Motors (Gibbons, 1992). In his original model Stackelberg's assumption that firms set quantities assumes that follower firms use Cournot reaction functions. Boyer and Moreaux (1987) and Gibbons (1992) also suggest that Stackelberg's model can also incorporate price setting behavior, Bertrand reaction functions. For purposes of discussion a Stackelberg duopoly game is presented using quantity setting behavior for the duopoly market described in section 2.3.2.

In the Stackelberg game three steps occur: (1) firm one (the leader) chooses a quantity $q_1 \geq 0$, (2) firm two (the follower) chooses its optimal output level $q_2 \geq 0$ after observing q1, (3) the payoff the firm *i* is given by that firm's profit function. As Gibbons (1992) illustrates to solve for the backward-induction outcome one computes firm two's reaction or reaction function $R_2(q_1)$ for an arbitrary quantity produced by firm one

$$\max_{0 \leq q_2 < \infty} \pi_2(q_1, q_2) = \max_{0 \leq q_2 < \infty} q_2[a - q_1 - q_2 - c] \tag{2.10}$$

$$R_2(q_1) = \frac{1}{2}(a - q_1 - c) \tag{2.11}$$

Equation 2.3a is a similar equation but here the difference is that $R_2(q_1)$ is firm two's best response to the observed output choice of firm one whereas in equation 2.3a $R_2(q_1)=q_2^*$ is firm two's best response to firm one's hypothesized output choice.

Since firm one has complete information and can solve $R_2(q_1)$ as readily as firm two can, it incorporates $R_2(q_1)$ into its optimal choice. Firm one's maximization problem becomes

$$\max_{0 \le q_2 < \infty} \pi_1(q_1, R_2(q_1)) = \max_{0 \le q_2 < \infty} q_1[a - q_1 - R_2(q_1) - c] = \max_{0 \le q_2 < \infty} q_1 \frac{a - q_1 - c}{2} \qquad (2.12)$$

which yields

$$q_1^* = \frac{a-c}{2} \text{ and } q_2 = R_2(q_1^*) = \frac{a-c}{4} \qquad (2.13)$$

The market quantities that result illustrate the leader firm to have a distinct advantage; firm one markets more than firm two. Knowing how its rivals will behave results in a first mover advantage for the leader firm; the leader benefits at the expense of the followers.

2.3.5 Competitive Interaction Models: Menu Approach, Conjectural Variation, and Time Series

When assessing previous research regarding competitive interaction in oligopoly markets studies have taken three unique forms, they include a menu approach or nonnested model comparision, 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). The model which 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 tested similar to the type introduced by Vuong (1989). The menu approach gets its name because researchers infer firm behavior based upon which model interacts best with the data. 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 framework, they use a simple two tailed significance test to investigate contrasting models. Two general hypotheses tested are: (1) other things being equal, private labels are more likely to be introduced in categories with smaller cross-price sensitivity among national brands and 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 constrast 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. Price determination is not only a function of demand, but also the pricing rules or conduct of producers, manufacturers and retailers. Using 3SLS Kadiyali, Vilcassim and Chintagunta reject Bertrand-Nash pricing in favor of Stackelberg pricing. Since the elasticities generated in either model are significantly different from each other, 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 then Nash behavior is assumed and if one firm has a conduct parameter equal to one then a Stackleberg relationship is observed. Research utilizing CV models, include Liang (1987), Conrad (1989), Gasmi, Laffont, and Vuong (1992), Dhar and Cotterill (2002), Friedman and Mezzetti (2002) and Kinoshita, Suzuki, and Kaiser (2002). To illustrate 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 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 two chooses its optimal behavior after observing firm one's behavior and vice versa the observed choices are related time series events. Systematic investigation over time may illustrate causal 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.

In addition to these three general approaches, a reaction function approach has been suggested as a forth alternative. Utilized by Cotterill, Putsis and Dhar (2000), and Dhar and Cotterill (2002) this approach requires the estimation of reaction functions from first order conditions. This provides a functional form based on each player's best response given the underlying demand structure and competitive environment. Tirole (1988) suggests the reaction coefficients are a complex function of the demand coefficients and conjectures. This is very similar to the CV approach, where conjectural responses are often functions of demand parameters and conduct behaviors. In both approaches first order conditions are used to estimate reaction functions or conjectural responses. However, while the reaction approach is seen as a unique departure from the CV approach because it does not include the estimation of a conduct parameter and is not unique when compared to the menu approach. While the derivation of reaction functions allows for the incorporation of various types of behavior (i.e. Bertrand-Nash, Stackelberg) often the selection of the appropriate model includes goodness of fit tests. Therefore, just because this approach expands the CV approach by allowing for a larger variety of conjectures or interactions, the inevitability that the best model is selected by ad hoc testing illustrates this approach to be a menu approach with more complicated modeling. Authors using this approach should be complemented for their unique, dynamic, and highly flexible modeling of vertical market relationships, rather than the modified use of an existing approach. As a result menu, CV and times series casual approaches remain the basis for assessing competitive interaction in oligopoly markets.

2.3.6 Optimal Strategies and Market/Equilibrium Conditions

The optimal strategy for a particular firm and the resulting market and equilibrium conditions is widely debated in the literature. Singh and Vives (1984), later supported by Cheng (1985) in a geometric approach, and Gaudet and Moreaux (1990) in an initial endowment and limited resource model, illustrate that a firm's dominant strategy and resultant market conditions is determined by whether the goods are substitutes or complements. Under general assumptions it can be illustrated that Bertrand prices (quantities) are smaller (larger) than Cournot prices (quantities) regardless of whether the goods are substitutes of complements. As a result Bertrand strategies are seen as more efficient in terms of greater consumer and social surplus (Singh and Vives, 1984) and more competitive in terms of lower market-up/output ratios, larger average volumes and lower average prices (Amir and Jin, 2001). Consequently when the goods are substitutes, the firms can reinforce each other's market position by reducing quantities and keeping prices high by pursuing a Cournot strategy. Conversely, when the goods are complements, firms can reinforce each other's market positions by following a Bertrand strategy, accepting lower prices but marketing more product. As a result Cournot (Bertrand) strategies are firm dominant actions when the goods are substitutes (complements), but the social welfare and market efficiency is always better under Bertrand competition.

Boyer and Moreaux (1987) further contrast resultant conditions of game strategies with the incorporation of price Stackelberg and quantity Stackelberg strategies. They conclude that in terms of total surplus the ranking is first the Bertrand equilibrium, then the price Stackelberg, followed by the quantity Stackelberg and the Cournot equilibria for both substitutes and complements. In addition, they also address whether a firm will lead or follow in price or quantity Stackelberg game dependent upon whether the goods are substitutes or complements. If the goods are pure substitutes it is always better to be the follower. Once the leader has its price the follower can under-cut the leader and capture the whole market. If the goods are substitutes, not pure substitutes, it always to better to be a price setter rather than a quantity setter.

Based on the assumed strategies of oligopoly markets and equilibrium, conditions can vary between perfect competition and monopoly. Monopoly conditions exist only under extreme cases of collusion. Table 2 illustrates the possible outcomes given a duopoly with linear demands, homogeneous products and constant marginal costs.

Table 2: A duopoly market comparison of perfect competition, Cournot, Bertrand, Quantity Stackelberg, and monopoly competition given linear demands, homogeneous product and constant marginal costs

	Perfect Competition	Bertrand	Quantity Stackelberg	Cournot	Monopoly
Market Quantity	$(a-c)$	$(a-c)$	$\frac{3}{4}(a-c)$	$\frac{2}{3}(a-c)$	$\frac{1}{2}(a-c)$
Price	c	c	$\frac{1}{4}(a+3c)$	$\frac{1}{3}(a+2c)$	$\frac{1}{2}(a+c)$
Industry Profit	0	0	$\frac{3}{16}(a-c)^2$	$\frac{2}{9}(a-c)^2$	$\frac{1}{4}(a-c)^2$
Consumer Surplus	$\frac{1}{2}(a-c)^2$	$\frac{1}{2}(a-c)^2$	$\frac{15}{32}(a-c)^2$	$\frac{2}{9}(a-c)^2$	$\frac{1}{8}(a-c)^2$
Total Surplus	$\frac{1}{2}(a-c)^2$	$\frac{1}{2}(a-c)^2$	$\frac{9}{32}(a-c)^2$	$\frac{4}{9}(a-c)^2$	$\frac{3}{8}(a-c)^2$

Market demand curve is $D(p)=a-p$. Each firm has a constant marginal cost of c. Results shown for $a>c$

In this simple duopoly example, Bertrand games readily approximately perfect competition conditions, quantity Stackelberg games illustrates conditions between Bertrand and Cournot and Cournot games are seen to be more monopolistic.

Ultimately the optimal marketing strategy is a decision of strategy space, quantity, price, lead-follow, or follow-lead. However, a firm's optimum strategy is not a simplistic choice. Benoit and Krishna (1986) indicate that

> Any theory which relies on either variable [quantity or price] is flawed. A pure quantity strategy setting model is unsatisfactory because the process of price determination must then be designated to an artificial auctioneer. Pure price setting models are also flawed in that firms' production capacities are given exogenously.

Consequently Benoit and Krishna advocate models that incorporate or make adjustments for quantity and price behavior. However, others indicate the appropriate strategies may be situational. In the short run, production and resource flexibility may determine optimum firm behavior. If inputs and production are precommitted, quantity strategies are not viable. If short run flexibility exists, quantity strategies will outperform price strategies (Dixon, 1986). As a result, optimum firm behavior, with regards to strategic action, and the associated market outcomes, continues to be any area of intense debate.

2.4 Product Demand - Differentiation and Brand Development

Basic Economic theory illustrates that consumers, through consumption or use of goods, generate utility. The greater the utility generated the more enjoyment a consumer gains and the greater their willingness to pay. Therefore, basic theory suggests that as utility/enjoyment generated by a particular good increases, the greater the demand for that good; the Law of Demand (Colander and Sephton, 1996; Katz and Rosen, 1998). For producers, processors, and retailers it is essential to understand the forces behind product demand if they are to make appropriate investments in advertising, branding and/or product development. Understanding demand conditions is a primary step in strategic optimization. This chapter illustrates how production differentiation and advertising affect the demand relationship.

2.4.1 Production Differentiation

It has been argued that product differentiation is a key reason behind brand development. If all goods in a market are homogeneous the Law of One Price, the same good cannot sell for different prices in different locations at the same time, would prevail (Mankiw and Scarth, 2001). In an oligopoly the ability to price discriminate and utilize market power to generate increased returns is only achievable if products are differentiated. Highlighting and identifying product differences in a brand name is one method to illustrate differentiated products to customers.

When studying differentiated markets two concepts regarding product heterogeneity arise. Products are differentiated firstly, if consumers *think* they are and secondly, if customers *recognize* and *distinguish* physical or chemical differences (Carlton and Perloff, 2000). The difference between these two concepts is irrelevant because the customer is always right. However, the impact of differentiation on a firm's demand curve is important. In studies where homogeneous products are assumed, one common price prevails and the demand facing a firm depends on the total supply of its competitors, much like Cournot's model (Applebaum, 1982; Azzam and Pagoulatos, 1990; Bhuyan and Lopez, 1997; Iwata 1974; Karp and Perloff, 1989; Liu, Sun and Kaiser, 1995). The inverse demand function can be written as,

$$p = p_i = D(Q) \tag{2.14}$$

where

$$Q = q_1 + q_2 + \ldots + q_n \tag{2.15}$$

That is the price p_i that firm i receives depends on the quantity of its brand and that of all other competitors. For example if we assume a two good market with a linear inverse demand function, the demand facing firm i is

$$p = p_i = a - bQ = a - bq_1 - bq_2 \tag{2.16}$$

In this example a and b are positive constants where an increase in either firm's output increases market supply and reduces the market price-received by either firm-by an equal amount (Carlton and Perloff, 2000).

In the case where products are differentiated, i.e. imperfect substitutes, the inverse demand function for a two firm, two good market can be illustrated as

$$^{3}p_1 = a_0 - a_1 q_1 - a_2 p_2 \tag{2.17}$$

$$p_2 = b_0 - b_1 q_1 - b_2 q_2 \tag{2.18}$$

where, $a_0 > 0$, $b_0 > 0$, $|a_1| > |a_2|$, and $|b_1| > |b_2|$. Therefore, the more a firm succeeds in differentiating its product from that of its competitor, the more insulated its own price is from that price changes of competing goods. In extreme cases products are differentiated to the degree that the goods become unrelated and monopoly markets are carved out. With product differentiation firms face a downward sloping demand curve, a condition inconsistent with competitive markets. Feenstra and Levinsohn (1995) illustrate that product differentiation is a necessary condition, assuming no production constraints, single period games and no other externalities, if prices in Bertrand competition are to exceed marginal cost.

In the above examination of product differentiation and its influence on demand, one key concept is very attractive to firms; the ability to isolate a firm's own price from the prices of other competitive goods. The ability to negate the influence of competing goods allows firms to focus their pricing decisions and possibly exploit market power. Expanding upon this basic theory, Schmalenensee (1976) argues that few markets compete in price; prices remain relatively stable over time. Competition is rather influenced by advertising and product promotion. Consequently, in the literature product differentiation is illustrated to counter competitive pricing and promotion activities.

[3]In demand functions homotheticity in prices assumes that $a_2 = b_1$

2.4.2 Product Branding

Within noncompetitive competition/noncooperative oligopolies much interest is 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 products from one firm as different from those products offered by competing firms (Carlton and Perloff, 2000). In the scope of this research product differentiation is a major force driving brand development and marketing decisions. Carlton and Perloff (2000) 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.

From a branded product 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, is it possible for a processor to exert market power and extract price/quantity premiums from the marketplace. At the same time, retailers see the potential benefits of owning their own brands, setting terms of trade with processors, and pricing to maximize their own profits, rather than taking the processed branded price as given. With national control over distribution, they can leverage generic or private label products from processors in return for shelf space for branded product.

In each of the Canadian chicken and Australian egg industries implications of processor brand development versus retail marketing strategies are affected by the distribution of market power. While private label, store brands, actively seek to distribute market power to retailers, processor brand development implements the opposite, distribution of market power to processors. Producers may also seek to develop farm brands but this usually requires a collective organization of producers such as a producer cooperative. The success of such producer cooperatives can be marginal if not properly organized and maintained. Additionally, in Canada and Australia, the oligopoly market structure forces each processor and retailer to consider the actions of each other. As will be illustrated later the success of a product strategy not only lies in demand parameters, but also in the interactive games between producers, processors, and retailers. Consequently, the market implications of brand versus generic product development and promotion have implications for all participants.

2.4.3 Advertising

In addition to product differentiation, advertising has readily been explored as a major factor influencing demand. The conceptual theories interacting with generic and brand advertising generally investigate three models of informative advertising as a means to either change consumers' tastes and preferences, lessen consumers' search cost, or develop a perception of the products attributes and characteristics. Advertising is thereby seen as a non-product characteristic intended to increase demand.

The first informative advertising framework views informative advertising as a means to favorably change consumers' tastes and preferences towards a product through the provision of information (Galbraith, 1958; Powers, 1989). In this framework consumers' tastes and preferences are assumed to be fixed, with prices and income endogenously determining quantity demanded. Therefore, advertising shifts demand by changing exogenous variables and shifting consumers' utility functions. Nelson (1975) contradicts this approach indicating that as economists we have no clear theory of taste changes and that the discrepancy between economists indicates no clear resolution.

The second framework of informative advertising seeks to reduce the effective price consumers encounter by reducing consumers' search costs. An effective price equals the market price plus search cost. Search cost is the devotion of resources a consumer must utilize in order to ascertain price and quality information. Advertising is thought to reduce search costs and therefore the effective price. The reduction in search costs reduces the effective price consumers will pay for every quantity of product. As a result the entire demand curve shifts outward (Powers, 1989).

In the third framework, advertising indirectly affects demand through its influence on commodity characteristics (Lancaster 1966; Nichols 1985; Stigler and Becker 1958). This framework uses household production theory and assumes that households combine inputs, such as market products, time and information, to produce final goods. Advertising is viewed as a means to provide information, allowing for more efficient production of final goods resulting from a cost-saving input. Therefore, advertising is seen to reduce the shadow price of a particular good by allowing for more efficient utilization of that good's characteristics (Jones and Ward, 1989). The quantity demanded of the input changes when advertising improves productivity, since the implicit prices of the inputs and final goods change. Becker and Murphy (1993) offer a variant of this model and state that advertising is a complement good, which yields favorable notice to another good. They refute the first framework, indicating the goods that positively affect the demand curves for other goods, are complements, not shifters of demand functions.

Independent of which framework a firm chooses to utilize, the goal with either of generic or brand product advertising is the same, to increase product returns and profitability. Adams and Yellen (1977) illustrate that advertising's influence on demand and therefore returns can be divided into two effects. Firstly, the ability of advertising to create or maintain awareness and provide information is proven to increase demand, thereby augmenting the surplus producers, processors and retailers receive. Secondly if firms have the ability to price discriminate, partially or entirely, advertising changes the extent to which existing surplus can be converted into profit. The ability to price discriminate is seen as a key influence over the success of generic or brand product advertising because it implies that products can be differentiated. Generic and brand product advertising can be cooperative or predatory/cannibalistic in nature with the determination relying on the degree of differentiation (Brester and Schroeder, 1995; Forker and Ward, 1993). This realization illustrates that generic advertising seeks to enlarge the total value of a product category, while brand advertising is aimed at reallocating the distribution of that value between sellers (Kinnucan and Clary, 1995)

If individual goods in a category class are homogenous/generic (cooperative goods), advertising expenditure on either branded or generic products will increase market demand with no reallocation of market share, a complementary effect. Conversely, if goods are differentiated and the market exhibits little room for expansion (predatory goods), then brand advertising seeks to draw market share away from competitors. Freidman (1958) initialized this predatory interaction with his discussion that advertising by one firm cancels out advertising by another and that the most effective advertising firm seeks to gain the most. Between branded goods, Nelson (1974) illustrates that firms with lower price per unit of utility of the brand possesses a distinct advantage and aim to benefit the most from increased advertising. In markets where goods exhibit cooperative and predatory characteristics brand advertising may increase market demand (Hall and Foik, 1983) and reallocate market share while generic advertising is expected to solely increase market demand.

Theoretically the incentive for firms to participate in generic adverting is clear, but given the empirical evidence, proper action is debatable. In some studies brand and generic advertising utilized together are found to have a cooperative effect and increase total demand (Hall and Foik, 1982; Kinnucan and Fearon, 1986) while in other studies neither brand (Blisard and Blaylock, 1992; Lee,Fairchild and Behr, 1988) nor generic advertising (Jones and Ward, 1989) had any effect on aggregate demand. More recently Clary (1993) found that generic advertising increased farm level prices and Ward and Lambert (1993) estimate that the US beef check-off program, a portion of which is devoted to research, development, and advertising, has a $5.71 return for every $1 invested. The conflicting research illustrates that generic or brand advertising success is specific to the situation. Firms must carefully allocate advertising investment as part of their optimal marketing strategy.

2.5 Returns to Research and Development

In the previous section, advertising was sought to have two unique effects on product returns and profitability. Its influence in maintaining or creating a branded/differentiated product image and increasing demand are thought of as positive benefits. In addition to investing in advertising, many agricultural markets have sought to generate further returns through investments in research and development (R&D). While there is much controversy about the actual effectiveness and returns to R&D programs, this section investigates the theoretical reasoning behind its use.

Alston, Norton and Pardey (1995) illustrate two different approaches for analyzing the effects for R&D. The first accounts for firm level changes in production as a result of

R&D, while the second examines industry supply changes as an aggregated account of firm level production choices. In the production approach research induced benefits derived from changes in knowledge may include more output for a given level of input, cost savings for a given quantity of input, new and better products, better organization and quicker responsiveness to changing circumstances. These benefits as derived from investments in R&D are a result of improvements in the production process. Algebraically, Alston, Norton and Pardey (1995) illustrate agricultural production in time *t*, Q_t, as a function of conventional inputs, X_t, various infrastructure variables such as roads, communication services, irrigation and education, Z_t, uncontrolled factors such as weather, Wt, and the flow of services, F_t, derived from changes in the stock of knowledge, K_t, and the adoption rate knowledge .

$$Qt = q(X_t, Z_t, W_t, F_t) \tag{2.19}$$

In this production function, investments in research can lead to changes in productivity via changes in conventional input quality or price, increases in the stock of knowledge, or by increasing the adoption/utilization of the current stock of knowledge. From a firm perspective, improvements in the production process which require less commitment of resources are seen as positive benefits to R&D.

In the second approach, the supply approach, improvements in production alter the relationship between inputs and outputs resulting in a technical change. The change in technology affects the relationship between production costs and output thus between supply and price. Therefore, investments in R&D allow for better firm level production processes, which from a supply analysis, create a technological change and shift the market supply curve outward. The benefits of supply increases are often controversial and largely depend on the elasticity of both supply and demand. As demand becomes inelastic consumers primarily benefit while producers see little return and often may be made worse off. As supply becomes inelastic, producers will see greater returns for R&D investment (Oemke and Crawford, 2002). Alston *et al* (2000) present historical evidence to help reduce some of the uncertainty regarding returns to R&D. In their study, they query 289 previous agricultural studies and confirm a mean rate of return of 65%. In the agricultural sector returns to R&D are generally positive.

2.6 Summary

As the literature reveals there are numerous approaches when assessing noncompetitive interaction in oligopoly markets. Prior research has primarily focused on menu or CV models to ascertain appropriate market conduct. Strategic conduct normally considered includes quantity (Cournot) games, price (Bertrand) games, and leader/follower (Stackelberg) games. Recently research has improved the understanding of retail price determination by recognizing that the underlying vertical channel structure can affect prices just as participant conduct or strategic action may. To further understand the nature of processor strategic action product demand, as it relates to product differentiation, brand development and advertising must be reviewed. Accurately describing the factors affecting a products demand helps processors better understand the implications of their decisions. Given all this, processor optimal strategies remain an area of intense debate and seem to be market specific.

As an extension to investments in advertising, investments in research are also highlighted. From a producer perspective, investments in either advertising or research are two off-farm approaches readily considered to increase returns. Optimal investment in either may be a function of market structure and conduct.

The next chapter utilizes the theoretical concepts presented in literature review to develop a structural demand model incorporating processor conduct. The presented model represents an empirical basis for synthetic modeling of generic adverting and research for the Canadian chicken meat and Australia egg markets.

3.0 Empirical Model Development

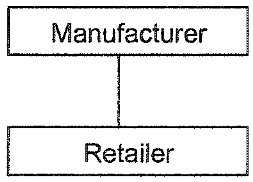
From the introductory chapter it is clear that the Canadian poultry meat market and Australian egg market are multiple stage, vertical market channels, with producers, processors, retailers, and final customers. Given the increasing concentration of processors and retailers, Cotterill (2000) and Dhar 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 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 Rayner (2001) draw 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 in uncertain conditions, over changing prices when 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 price 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" research, 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. That 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. In this section, structural models and market conducts used in previous empirical estimation are presented . From these an empirical model is developed given constraints of available data.

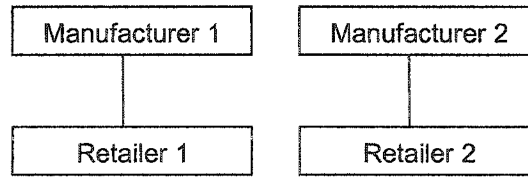
3.1 Previous Approaches

In Figure 1 five successive stage oligopoly models are presented. While each model appears to be unique one to four are specialized cases for the generalized case, model five. Exploration of these models will aid in the development of the empirical model estimated in this research.

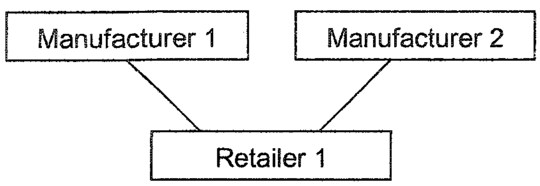
Figure 1: Five successive stage oligopoly models.



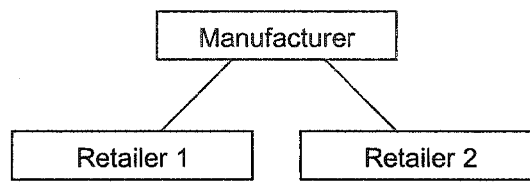
Model 1
Totally Differentiated Products;
Bilateral Monopoly
(Jueland and Shugan, 1983)



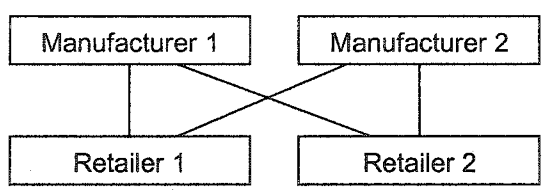
Model 2
Differentiated but Substitutable
Products; Separate Retail Markets
(McGuire and Staelin, 1983)



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



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



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

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 manufacturers 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, a single manufacturer supplying multiple retailers (Cotterill, 2000). The manufacturer can provide the retailers with homogeneous products or differentiated products. Demand for the manufacturer's product is derived via the competition between retailers. Model five is the generalized case where multiple manufacturers offer homogenous or differentiated products to multiple retailers (Lee and Staelin, 1997). By instituting various rules, restrictions or product offerings, 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 manufacturers that become the basis for research presented by Cotterill, 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 model assumes 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) and graphically illustrated in Appendix 2 Figure A4 are

Vertical Nash (VN).[4] 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 manufacturer 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 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.

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[4] The term Vertical Nash as described by Choi (1991) is used in order to distinguish this game from the horizontal game played between different channels (interchannel competition). Often horizontal, price competition may be modeled by Bertrand price competition or Stackelberg leader follower relationships between horizontal opponents. Such a competition is empirically illustrated by Kadiyali, Vilcassim and Chintagunta (1996).

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 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 unavailability of wholesale prices for Canadian chicken and Australian eggs, the theoretical model presented next and later used for empirical estimation only investigates processor strategic action.

3.2 The Model

The objective of previous research has often been to model processor/manufacturer action in a fully structural model. In such models, both retail and wholesale prices are endogenously determined. In this research, the utilization of a fully structural system is limited by provision of solely retail level data. Given this restriction, and using an approach similar to Kadiyali, Vilcassim, and Chintagunta (1996) is employed to extract processor conduct from the role of the retailer.

Think of the following sequence of moves being played in the market (repeatedly): the 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.

To begin, a generalized Bertrand-Nash game is illustrated, followed by the development of a generalized Stackelberg game.

3.2.1 Initial Structure

The demand facing each firm is assumed to be linear in prices, and can be represented as follows,

$$q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i \tag{3.1}$$

where i =1…n, j =1…n, n equals the number of processors being considered, q_i, and p_i represent the quantity and price of processor i, α_i, and γ_{ij} represent demand parameters to be estimated and X_i represents a vector 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 symmetry (i.e $\gamma_{ij} = \gamma_{ji}$). Homogeneity of degree zero is imposed by dividing each price by the consumer price index (*CPI*).

Processor profit functions can be illustrated as

$$\pi_i = (p_i - mc_i)q_i \tag{3.2}$$

where π_i and mc represent profit and marginal cost of manufacturing for processor i. In this profit function, the use of marginal cost rather than average cost assumes that fixed costs make up an insignificant portion of the final good's cost. Therefore marginal cost is assumed to be an accurate approximation of a good's average cost. Previous research supporting this approach include Liang (1987), Kadiyali, Vilcassim, and Chintagunta (1999), Cotterill (2000), Dhar and Cotterill (2002), and Kinoshinta, Suzuki, and Kaiser (2002),

3.2.2 Bertrand-Nash Game

In the Bertrand-Nash game each processor develops a marketing strategy by optimizing their own price with respect to their profit function. This type of competition models direct horizontal price competition between processors. The derivation of the first order condition (FOC), as required for a maxima, follows as such,

$$\frac{\partial \pi_i}{\partial p_i} = \frac{\partial (p_i - mc_i)}{\partial p_i} q_i + \frac{\partial q_i}{\partial p_i}(p_i - mc_i) = 0 \qquad 3.3$$

where $\frac{\partial (p_i - mc_i)}{\partial p_i} = 1$, $\frac{\partial q_i}{\partial p_i} = \frac{\gamma_{ii}}{CPI}$ and $q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i$.

Substituting the previous two partial derivatives and demand equation (3.1) into equation (3.2) we get

$$\frac{\partial \pi_i}{\partial p_i} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i + \gamma_{ii} \frac{(p_i - mc_i)}{CPI} = 0 \qquad (3.4)$$

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

$$p_i = -\frac{1}{2\gamma_{ii}}\left(a_i CPI + \sum_{i \neq j} \gamma_{ij} p_j + X_i CPI \right) + \frac{mc}{2} \qquad (3.5)$$

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

$$q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i + \varepsilon_i \qquad (3.6\text{ a})$$

$$p_i = -\frac{1}{2\gamma_{ii}}\left(a_i CPI + \sum_{i \neq j} \gamma_{ij} p_j + X_i CPI \right) + \frac{mc}{2} + \varepsilon_{i+n} \qquad (3.6\text{ b})$$

The errors ($\epsilon_1 \ldots \epsilon_{n+i}$) are econometric estimation errors that result when missing data or uncertainty is encountered. As will be illustrated in the next chapter, the interrelatedness of these errors warrant the use of seemingly unrelated regression (SUR), rather than individual estimation of the above equations.

3.2.3 Stackelberg Game

In a price leadership or Stackelberg game, one processor (processor k, where $k = 1 \ldots n$, and $k \neq i$) 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 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 avoid researcher estimation bias (Kadiyali, Vilcassim, and Chintagunta, 1996). In this example the followers' FOCs and simplified reactions are,

$$\frac{\partial \pi_i}{\partial p_i} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i + \gamma_{ii} \frac{(p_i - mc_i)}{CPI} = 0 \tag{3.7 a}$$

$$p_i = -\frac{1}{2\gamma_{ii}} \left(a_i CPI + \sum_{i \neq j} \gamma_{ij} p_j + X_i CPI \right) + \frac{mc}{2} \tag{3.7 b}$$

where $i = 1 \ldots n$, excluding $i = k$.

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.

$$\pi_k = (p_k - mc) q_k \tag{3.8}$$

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

$$\pi_k = (p_k - mc) \left(\alpha_{ki} + \sum_{i=1}^{n} \gamma_{ki} \frac{p_i}{CPI} + X_k \right) \tag{3.9}$$

Third, the leader forms a conjecture about the followers conduct, substituting the followers' price reaction functions from equations (3.7 b) into its own profit function to replace all p_i ($k \neq i$). Lastly, completing the leader's FOC and solving with respect to p_k, the leader's price reaction function is defined.

$$p_k = -\frac{1}{2\gamma_{kk} - \sum_{j \neq k} \frac{\gamma_{ki}^2}{\gamma_{ii}}} \left(a_k CPI + \sum_{j \neq i} \gamma_{ki} p_i + X_k CPI - mc \left(\gamma_{kk} - \sum_{j \neq i} \frac{\gamma_{ki}^2}{\gamma_{ii}} \right) \right) \tag{3.10}$$

This substitution and derivation of the leader's price reaction equation follows very closely to that of equation (3.5)

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

$$q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \frac{p_j}{CPI} + X_i + \varepsilon_i \tag{3.11 a}$$

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

(3.11 b)

$$p_i = -\frac{1}{2\gamma_{ii}} \left(a_i CPI + \sum_{i \neq j} \gamma_{ij} p_j + X_i CPI \right) + \frac{mc}{2} + \varepsilon_{i+n} \tag{3.11 c}$$

where $i = 1 \ldots n$, excluding $i = k$.

3.2.4 Bertrand-Nash and Stackelberg Games with Cooperative Participation

The above Bertrand-Nash and Stackelberg models were derived assuming that each market participant was an investor owned firm (IOF). However, as mentioned above, Lilydale is a producer cooperative and consequently may have different objectives. While the objective of an IOF is to maximize profits, the theoretical objective of a producer cooperative is to maximize member welfare. A cooperative objective function maximizes member welfare when profits and producer surplus are simultaneously maximized (Fulton, 1998). Given this objective function optimum pricing no longer solely utilizes market power to drive higher profits. The simultaneous optimization of profits and producer surplus is achieved in equilibrium when price is set equal to marginal cost, the socially optimum level. Therefore, a cooperative's price reaction function is no longer a function of demand parameters and other firms' prices, but rather a function of marginal cost.

In this research the cooperative pricing rule is given as

$$p_i = mc_i + basis \tag{3.12}$$

where for cooperative i p_i is the optimum retail price, mc is the marginal cost, and the *basis* is the historical difference between price and marginal cost in real terms. For Lilydale this basis is estimated at \$6.12/kg. It is noted that a weekly growth rate of 0.103% is observed. While this basis growth may be a reflection of producer price increases, it may also illustrate changes in other processing costs such as electricity, labor, transportation, etc. Given the absence of other input cost data, the basis was assumed to be an exogenous variable for Lilydale.

With the introduction of a new pricing rule for Lilydale, the Bertrand-Nash and Stackelberg games must be revisited. In addition, one must also consider two scenarios. Scenario one allows Lilydale to act as a producer cooperative, but other market participants still treat Lilydale as an IOF. Scenario two allows Lilydale to act and be treated as a producer cooperative by other market participants. The idea that competing firms may treat a cooperative as an IOF, despite declaration of cooperative objectives is an advancement in theoretical reasoning not covered in previous literature. As such it is seen as an innovation of this research. Bertrand-Nash and Stackelberg games are examined for each scenario.

Scenario One: Lilydale acts as producer cooperative, but is treated as a IOF by other market participants

In the Bertrand game, Lilydale prices according to equation (3.12), while Maple Leaf and generic processors price according to equation (3.5). In the Stackelberg game, Lilydale prices according to the marginal cost rule and therefore never leads or uses foresight to set prices. Its price reaction function is not dependent upon the actions of other processors. When other market participants lead, they ignore Lilydale's cooperative pricing rule and treat them as an IOF. Therefore, the following IOF firm prices according to equation 3.5 while the leading IOF prices according to 3.10.

Scenario Two: Lilydale acts a producer cooperative and is treated as a cooperative by other market participants

In the Bertrand-Nash game, no market participant's price reaction function is influenced by another firm's price decision, therefore the Bertrand-Nash game is the same as under scenario one. When Stackelberg games are considered, Lilydale does not lead for similar reasons as presented under condition one, but when other IOF firms treat Lilydale as a cooperative, their price reaction functions must reflect Lilydale's cooperative pricing function. Given that Lilydale prices according to marginal cost, its optimal price is no longer influenced by changes in other firms' prices. If Lilydale is considered to be firm (1) and Maple Leaf and generic processors are considered to be firms (2) and (3) then

$\frac{\partial p_1}{\partial p_2} = \frac{\partial p_1}{\partial p_3} = 0$. Recalculating the Stackelberg games the price reaction functions Maple Leaf and generic processors become,

$$p_2 = -\frac{1}{2\gamma_{22} - \frac{\gamma_{23}^{\ 2}}{\gamma_{33}}}\left(a_2 CPI + \gamma_{12} p_1 + \gamma_{23} p_3 + X_2 CPI - mc\left(\gamma_{22} - \frac{\gamma_{23}^{\ 2}}{\gamma_{33}}\right)\right) \tag{3.13}$$

$$p_3 = -\frac{1}{2\gamma_{33} - \frac{\gamma_{23}^{\ 2}}{\gamma_{22}}}\left(a_3 CPI + \gamma_{13} p_1 + \gamma_{23} p_3 + X_3 CPI - mc\left(\gamma_{33} - \frac{\gamma_{23}^{\ 2}}{\gamma_{22}}\right)\right) \tag{3.14}$$

3.3 Summary

In any oligopoly market the specification of market structure and participant conduct dramatically influence empirical estimates. Given multiple processors, retailers and products a fixed markup pricing rule is assumed to abstract horizontal processor conduct from retail level data. Bertrand-Nash and Stackelberg games are purposed as possible participant conducts to be used in the empirical model estimation that proceeds in the next chapter.

4.0 Empirical Model Estimation and Selection

In this chapter, processor Bertrand-Nash and Stackelberg conducts are imposed on a vertical market channel used for empirical estimation. This creates a menu of appropriate models from which a preferred model is chosen. Market prices and quantities are illustrated to be a function of market structure and processor conduct.

4.1 Data

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

For Canada fresh chicken, weekly retail price and quantity data were available from the first week 2001 through to the 44th week of 2003. In contrast to Australian eggs, the majority of fresh chicken in Canada in marketed as generic product. Market shares on average are approximately 5% Maple Leaf Prime, 1% Lilydale Gold, and 94% 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 weekly, generic or brand specific advertising data was available for Canadian chicken. Average weekly processor and producer prices were obtained from Agriculture and Agri-food Canada: Poultry Market (2004). Given the concentration of generic and Maple Leaf processing and production in eastern Canada, Ontario producer prices were used. However, given that Ontario processor prices were unavailable, New Brunswick processor prices were used as the best available estimate. For Lilydale, an exclusively western processor, Albertan processor and producer prices were used. Processor prices were used as an estimate of marginal cost for processors, rather than producer prices in an attempt to reflect processing costs. 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.

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, Pace Farms, Sunny Queen, and Farm Pride, and private label eggs were assumed to be major market brands. The remaining egg production not accounted for by these four is assumed to be generic egg production. 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 advertise nationally, 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). Processor prices were unattainable. Linear interpolation was used to derive quarterly estimates. Quarterly CPI estimates were obtained from the Australian Bureau and Statistics. Appendix 3, figures A5 to A11 graphically illustrate price, quantity and advertising data.

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

Canada

$$X_i = \mu_{i1} Time + \mu_{i2} Exp \tag{4.1}$$

Australia

$$X_i = \sum_{j \neq 1}^{n} - \frac{\lambda_{ij}}{\left(\dfrac{adv_j}{CPI} \right)} + \mu_{i1} Time + \mu_{i2} Exp \tag{4.2}$$

where adv_i is advertising expenditure by firm i, *Time* is a time trend index, *Exp* is expenditure, and λ and μ are parameters to be estimated. Recall that X_i is the matrix of exogenous variables that substitutes into demand equation (3.1). The incorporation of advertising as an inverse relationship assumes diminishing returns to advertising. Additionally, during estimation, lagged dependent variables for both demand and price reaction equations were considered; these lagged dependent variables produced insignificant and theoretically counterintuitive results. As such, they were omitted from the final estimation.

4.2 Empirical Estimation

It is apparent in this model, that systems of equations must be estimated. Joint estimation is a requirement given the imposition of cross equation restrictions and the likelihood of cross equation error (ϵ) correlation. As mentioned in the previous chapter, error terms accumulate variation that is not accounted for by model explanatory variables. Factors omitted from an equation, including missing data, omitted explanatory variables and/or uncertainty, are accounted for in the error term. Since most estimation procedures, for either single equation estimation or simultaneous equation estimation, choose parameter estimates which minimizes these errors or disturbances, proper understanding of error distribution and relatedness is important if one wishes to obtain an unbiased estimator. When error terms between equations are related, the use of SUR to account for this relatedness results in an unbiased estimator. The following example justifies the use of SUR when estimating the equation systems previously illustrated. The example follows from Griffiths, Hill, and Judge (1993).

Consider the following system of equations,

$$\begin{aligned} y1 &= x_{11}\beta_{11} + x_{12}\beta_{12} + \varepsilon_1 \\ y_2 &= x_{21}\beta_{21} + x_{22}\beta_{22} + \varepsilon_2 \end{aligned} . \tag{4.3}$$

Expressed as a single statistical model

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} x_{11} & x_{12} & 0 & 0 \\ 0 & 0 & x_{21} & x_{22} \end{bmatrix} \begin{bmatrix} \beta_{11} \\ \beta_{12} \\ \beta_{21} \\ \beta_{22} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} . \tag{4.4}$$

In more compact form the model may be written as

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \tag{4.5}$$

where $X_1 = [x_{11} \quad x_{12}]$, $X_2 = [x_{21} \quad x_{22}]$, $\beta_1 = \begin{bmatrix} \beta_{11} \\ \beta_{12} \end{bmatrix}$, and $\beta_2 = \begin{bmatrix} \beta_{21} \\ \beta_{22} \end{bmatrix}$

or

$$y = X\beta + \varepsilon \tag{4.6}$$

where $y = \begin{bmatrix} y_1 \\ y_2 \end{bmatrix}$, $X = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix}$, $\beta = \begin{bmatrix} \beta_1 \\ y_2 \end{bmatrix}$.

If cross equation errors are not related (i.e $E[\varepsilon_1 \varepsilon_2'] = 0$) the corresponding error vectors may be specified as $\varepsilon = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, E\begin{pmatrix} \varepsilon_1\varepsilon_1' & \varepsilon_1\varepsilon_2' \\ \varepsilon_2\varepsilon_1' & \varepsilon_2\varepsilon_2' \end{pmatrix} = \begin{pmatrix} \sigma_1^2 I_T & 0 \\ 0 & \sigma_2^2 I_T \end{pmatrix}\right]$

The covariance matrix to be used in the generalized least squares (GLS) estimator, $\hat{\beta} = (X'W^{-1}X)^{-1} X'W^{-1}y$, is

$$W = E\left[\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} \begin{pmatrix} \varepsilon_1' & \varepsilon_2' \end{pmatrix}\right] = E\begin{bmatrix} E[\varepsilon_1\varepsilon_1] & E[\varepsilon_1\varepsilon_2'] \\ E[\varepsilon_2\varepsilon_1'] & E[\varepsilon_2\varepsilon_2'] \end{bmatrix} = \begin{bmatrix} \sigma_1^2 I_T & 0 \\ 0 & \sigma_2^2 I_T \end{bmatrix} \tag{4.7}$$

This approach is the same as estimating each equation individually. However, when between equation errors are related, the assumption $E[\varepsilon_1 \varepsilon_2'] = 0$ not longer holds true. The GLS estimator is no longer unbiased because the covariance matrix does not account for error interrelatedness. For example, while we may make our best attempts to include proper explanatory variables, undoubtedly, some will be omitted. Omitted explanatory variables similar to each equation forces errors to be related since this omitted information is accumulated in the error term. Related error terms for the same time period are considered contemporaneously correlated. To derive unbiased estimator a new estimate of W is required.

In the new estimate of W, with contemporaneously correlation of errors, the covariance of errors between equations is no longer zero. For example

$\operatorname{cov}(\varepsilon_1 \varepsilon_2) = E[\varepsilon_1 \varepsilon_2] = \sigma_{12} \neq 0$

The corresponding error vectors are now specified as

$$\varepsilon = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, E\begin{pmatrix} \varepsilon_1 \varepsilon_1' & \varepsilon_1 \varepsilon_2' \\ \varepsilon_2 \varepsilon_1' & \varepsilon_2 \varepsilon_2' \end{pmatrix} = \begin{pmatrix} \sigma_1^2 I_T & \sigma_{21} I_T \\ \sigma_{21} I_T & \sigma_2^2 I_T \end{pmatrix}\right]$$

where $\sigma_{12} = \sigma_{21}$ are the covariances that reflect the contemporaneous correlation between errors. Accounting for error covariance allows for proper estimation of *W*, which can then be used in the GLS estimator to derive unbiased estimates of parameters. In this research, given the imposition of cross equation restrictions and the likelihood that errors are contemporaneously related, SUR procedures for GLS estimation result in an unbiased estimator.

4.2.1 Empirical Estimation: Canadian Chicken Market

Using Times Series Processor (TSP) software SUR was performed assuming three chicken processors: (1) Lilydale, (2) Maple Leaf Prime, and (3) Generic. Using the generalized equation system format illustrated in chapter 3, nine SUR estimations were completed; two Bertrand-Nash models and seven Stackelberg. R-squared values (Table 3) illustrate relative good explanatory power for demand equations, but rather poor explanatory power for price reaction equations. This is especially present in Lilydale and Generic price reaction equations. Additionally, own-price elasticity of demand, cross-price elasticity of demand, and price reaction equation elasticities were calculated at the means. Tables 4 to 6 summarize Marshallian demand elasticities, Hicksian demand elasticities, and price reaction elasticities. Parameter estimates with standard errors and p-values are illustrated in Appendix 4 Tables A2 to A10. An explanation of Marshallian and Hicksian demand elasticities proceeds in Appendix 4 figure A12.

Table 3: Bertrand-Nash and Stackelberg model Goodness of Fit Statistics for Canadian Chicken: R-Squared Values

	Lilydale operates as IOF				Lilydale operates as producer cooperative				
			Market participants treat Lilydale as IOF			Market participants treat Lilydale as IOF		Market participants treat Lilydale as producer cooperative	
	Bertrand	Stackelberg Lilydale	Stackelberg Maple Leaf	Stackelberg Generic	Bertrand	Stackelberg Maple Leaf	Stackelberg Generic	Stackelberg Maple Leaf	Stackelberg Generic
Demand Equation									
Lilydale	0.664	0.632	0.656	0.683	0.673	0.651	0.674	0.673	0.673
Maple Leaf	0.657	0.659	0.664	0.658	0.663	0.660	0.662	0.663	0.663
Generic	0.971	0.971	0.972	0.972	0.974	0.974	0.974	0.974	0.974
Price Reaction Equation									
Lilydale	0.082	0.086	0.067	0.083	0.992	0.992	0.992	0.992	0.992
Maple Leaf	0.365	0.450	.0415	0.368	0.290	0.245	0.291	0.290	0.291
Generic	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004

Table 4: Bertrand-Nash and Stackelberg model Marshallian own price, cross price, and income elasticities for Canadian Chicken: Lilydale treated as both producer cooperative and IOF

	Lilydale operates as IOF				Lilydale operates as producer cooperative				
			Market participants treat Lilydale as IOF			Market participants treat Lilydale as IOF		Market participants treat Lilydale as producer cooperative	
	Bertrand	Stackelberg Lilydale	Stackelberg Maple Leaf	Stackelberg Generic	Bertrand	Stackelberg Maple Leaf	Stackelberg Generic	Stackelberg Maple Leaf	Stackelberg Generic
Own Price Elasticity									
$\epsilon 11$	-1.355*	-0.705*	-1.341*	-1.357*	-1.293*	-1.099*	-1.304*	-1.293*	-1.293*
$\epsilon 22$	-0.812*	-0.866*	-0.489*	-0.810*	-0.693*	-0.700*	-0.698*	-0.690*	-0.695*
$\epsilon 33$	-1.187*	-1.217*	-1.174*	-1.166*	-1.095*	-1.089*	-1.080*	-1.094*	-1.093*
Cross Price Elasticity									
$\epsilon 12$	1.673*	1.727*	2.332*	1.601*	2.231*	3.397*	2.190*	2.231*	2.232*
$\epsilon 13$	-0.787*	-1.431*	-1.299*	-0.610**	-1.257*	-2.154*	-1.178*	-1.252*	-1.270*
$\epsilon 21$	0.255*	0.263*	0.355*	0.244*	0.340*	0.517*	0.333*	0.340*	0.340*
$\epsilon 23$	0.376*	0.695*	0.228	0.184	-0.139	-0.171	-0.199	-0.150	-0.127
$\epsilon 31$	-0.012*	-0.021*	-0.019*	-0.009**	-0.019*	-0.032*	-0.017*	-0.019*	-0.019*
$\epsilon 32$	0.037*	0.068*	0.022	0.018	-0.014	-0.017	-0.019	-0.015	-0.012
Income Elasticity									
η_1	0.374**	1.037*	0.382**	0.383**	0.705*	0.652*	0.700*	0.705*	0.702*
η_2	1.164*	0.967*	1.289*	1.136*	1.095*	1.195*	1.091*	1.094*	1.097*
η_3	0.960*	0.969*	0.947*	0.963*	0.965*	0.957*	0.966*	0.965*	0.965*

* Significance assumed at $P \leq 0.05$
** Significance assumed at $P \leq 0.10$
Where for ϵij, i and j take the values: 1-Lilydale, 2-Maple Leaf, 3-Generic

NO TEXT

Table 5: Bertrand-Nash and Stackelberg model Hicksian own price, and cross price elasticities for Canadian Chicken: Lilydale treated as both producer cooperative and IOF

	Lilydale operates as IOF				Lilydale operates as producer cooperative				
			Market participants treat Lilydale as IOF			Market participants treat Lilydale as IOF		Market participants treat Lilydale as producer cooperative	
	Bertrand	Stackelberg Lilydale	Stackelberg Maple Leaf	Stackelberg Generic	Bertrand	Stackelberg Maple Leaf	Stackelberg Generic	Stackelberg Maple Leaf	Stackelberg Generic
Own Price Elasticity									
$\epsilon 11$	-1.350*	-0.691*	-1.335*	-1.352*	-1.284*	-1.090*	-1.294*	-1.284*	-1.284*
$\epsilon 22$	-0.710*	-0.781*	-0.375*	-0.710*	-0.597*	-0.595*	-0.602*	-0.593*	-0.599*
$\epsilon 33$	-0.319*	-0.342*	-0.318*	-0.296*	-0.222*	-0.224*	-0.207*	-0.222*	-0.220*
Cross Price Elasticity									
$\epsilon 12$	1.706*	1.818*	2.366*	1.634*	2.293*	3.454*	2.251*	2.293*	2.294*
$\epsilon 13$	-0.448	-0.494	-0.954*	-0.264	-0.620	-1.565*	-0.546	-0.615	-0.635
$\epsilon 21$	0.270*	0.276*	0.372*	0.259*	0.354*	0.533*	0.348*	0.354*	0.354*
$\epsilon 23$	1.428*	1.569*	1.393*	1.210*	0.851*	0.910*	0.787*	0.839*	0.864*
$\epsilon 31$	0.001	-0.008**	-0.007	0.004	-0.006	-0.019*	-0.005	-0.006	-0.006
$\epsilon 32$	0.121*	0.153*	0.106*	0.103*	0.071*	0.068*	0.066*	0.070*	0.073*

* Significance assumed at $P \leq 0.05$
** Significance assumed at $P \leq 0.10$
Where for ϵij, i and j take the values: 1-Lilydale, 2-Maple Leaf, 3-Generic

Table 6: Bertrand-Nash and Stackelberg model price reaction equation elasticities for Canadian Chicken: Lilydale treated as both producer cooperative and IOF

	Lilydale operates as IOF				Lilydale operates as producer cooperative				
			Market participants treat Lilydale as IOF			Market participants treat Lilydale as IOF		Market participants treat Lilydale as producer cooperative	
	Bertrand	Stackelberg Lilydale	Stackelberg Maple Leaf	Stackelberg Generic	Bertrand	Stackelberg Maple Leaf	Stackelberg Generic	Stackelberg Maple Leaf	Stackelberg Generic
Price reaction Elasticity									
ϵ p1(p2)	0.617*	1.521*	0.8699*	0.590*	0.000***	0.000***	0.000***	0.000***	0.000***
ϵ p1(p3)	-0.290*	-1.260*	-0.4846*	-0.225**	0.000****	0.000***	0.000***	0.000***	0.000***
ϵ p2(p1)	0.157*	0.152*	0.5326*	0.150*	0.245*	0.862*	0.239*	0.246*	0.244*
ϵ p2(p3)	0.232*	0.401*	0.3414	0.114	-0.100	-0.285	-0.142	-0.109	-0.092
ϵ p3(p1)	-0.005*	-0.009*	-0.0082*	-0.004**	-0.009*	-0.015*	-0.008*	-0.008*	-0.009*
ϵ p3(p2)	0.015*	0.028*	0.0094	0.008	-0.006	-0.008	-0.009	-0.007	-0.006
ϵ p1(mc)	0.140***	0.106*	0.1395***	0.140***	0.279***	0.279***	0.279***	0.279***	0.279***
ϵ p2(mc)	0.155***	0.155***	0.0824*	0.155***	0.155***	-0.052	0.155***	0.154*	0.155***
ϵ p3(mc)	0.234***	0.234***	0.2340***	0.234*	0.234***	0.234***	0.233*	0.234***	0.234*

* Significance assume at P ≤0.05.
** Significance assume at P ≤0.10.
***Denotes a constant, rather than an estimated elasticity.
Where $\mathcal{E}$ p*i*(p*j*), is the price reaction equation elasticity for processor *i* with respect to price *j*
Where $\mathcal{E}$ p*i*(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

4.2.2 Empirical Estimation: Australia Egg Market

For estimation of the Australian egg model six SUR estimations were completed; one Bertrand-Nash model and five Stackelberg models giving each processor a chance to lead. Processors were (1) Sunny Queen, (2) Pace Farms , (3) Farm Pride, (4) private label, and (5) generic. R-squared values indicate relatively good explanatory properties for demand and price reaction equations across all models (Table 7). This is in contrast to the Canadian model where price reaction equations had relatively poor explanatory properties. Own-price elasticity of demand, cross-price elasticity of demand, advertising elasticities, and price reaction equation elasticities were calculated at the means. Tables 8 to 11 illustrate Marshallian demand elasticities, Hicksian demand elasticities, advertising elasticities, and price reaction elasticities. Parameter estimates with standard errors and p-values are illustrated in Appendix 4 Tables A11 to A16.

Table 7: Bertrand-Nash and Stackelberg model Goodness of Fit Statistics for Australian Eggs: R-Squared Values

	Bertrand	Stackelberg Sunny Queen	Stackelberg Pace Farms	Stackelberg Farm Pride	Stackelberg Private Label	Stackelberg Generic
Demand Equation						
Bertrand	0.943	0.943	0.944	.0944	0.943	0.943
Sunny Queen	0.919	0.921	0.926	0.917	0.924	0.878
Farm Pride	0.964	0.964	0.962	0.963	0.964	0.967
Private Label	0.974	0.974	0.975	.0975	0.974	0.967
Generic						
Price Reaction Equation						
Bertrand	0.611	0.582	0.589	0.611	0.586	0.564
Sunny Queen	0.685	0.685	0.699	0.984	0.984	0.666
Farm Pride	0.359	0.365	0.310	0.338	0.339	0.333
Private Label	0.571	0.571	0.575	0.571	0.569	0.559
Generic	0.545	0.546	0.289	0.539	0.564	0.797

Table 8: Bertrand-Nash and Stackelberg model Marshallian own price, cross price, and income elasticities for Australian Eggs

	Bertrand	Stackelberg Sunny Queen	Stackelberg Pace Farms	Stackelberg Farm Pride	Stackelberg Private Label	Stackelberg Generic
Own Price Elasticity						
$\epsilon 11$	-1.386*	-1.462*	-1.454*	-1.383*	-1.454*	-1.377*
$\epsilon 22$	-2.365*	-2.370*	-2.415*	-2.353*	-2.361*	-2.287*
$\epsilon 33$	-1.320*	-1.310*	-1.388*	-1.386*	-1.354*	-1.317*
$\epsilon 44$	-1.428*	-1.451*	-1.448*	-1.431*	-1.390*	-1.444*
$\epsilon 55$	-1.987*	-1.987*	-1.731*	-1.975*	-2.005*	-2.763*
Cross Price						
$\epsilon 12$	-0.041	-0.037	-0.036	-0.070	-0.002	0.147
$\epsilon 13$	0.555*	0.571*	0.543*	0.576*	0.538*	0.401*
$\epsilon 14$	0.170	0.163	0.239	0.151	0.106	-0.204
$\epsilon 15$	0.589	0.670**	0.603	0.599	0.594	0.137
$\epsilon 21$	-0.042	-0.038	-0.037	-0.072	-0.002	0.151
$\epsilon 23$	-0.628*	-0.631*	-0.665*	-0.627*	-0.629*	-0.575*
$\epsilon 24$	0.770*	0.777*	0.913*	0.783*	0.768*	0.553*
$\epsilon 25$	0.909*	0.884*	0.813*	0.915*	0.876*	1.565*
$\epsilon 31$	0.802*	0.825*	0.786*	0.833*	0.778*	0.581*
$\epsilon 32$	-0.884*	-0.887*	-0.936*	-0.882*	-0.885*	-0.809*
$\epsilon 34$	-0.414	-0.414	-0.561*	-0.410**	-0.393	0.027
$\epsilon 35$	-0.618	-0.604	-0.320	-0.610	-0.604**	-1.777*
$\epsilon 41$	0.069	0.066	0.097	0.061	0.043	-0.083
$\epsilon 42$	0.303*	0.306*	0.360*	0.309*	0.303*	0.218*
$\epsilon 43$	-0.116	-0.116	-0.157*	-0.115**	-0.110	0.007
$\epsilon 45$	1.291*	1.288*	1.097*	1.278*	1.344*	1.968*
$\epsilon 51$	0.185	0.210**	0.189	0.188	0.187	0.043
$\epsilon 52$	0.278*	0.270*	0.248*	0.280*	0.268*	0.478*
$\epsilon 53$	-0.134	-0.131	-0.070	-0.133	-0.131**	-0.386*
$\epsilon 54$	1.002*	1.000*	0.851*	0.992*	1.043*	1.527*
Income Elasticity						
η_1	-0.201	-0.191	-0.189	-0.198	-0.136	0.101
η_2	-0.054	-0.038	0.017	-0.043	-0.063	-0.608
η_3	1.015	0.985	0.974	1.018	1.038	1.707
η_4	2.385	2.383	2.457	2.398	2.340	2.143
η_5	0.394	0.379	0.285	0.385	0.395	0.833

* Significance assumed at $P \leq 0.05$
** Significance assumed at $P \leq 0.10$
Where for ϵij, i takes the values: 1-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, 5-Generic

Table 9: Bertrand-Nash and Stackelberg model Hicksian own price, cross price, and income elasticities for Australian Eggs

	Bertrand	Stackelberg Sunny Queen	Stackelberg Pace Farms	Stackelberg Farm Pride	Stackelberg Private Label	Stackelberg Generic
Own Price Elasticity						
$\epsilon 11$	-1.409*	-1.484*	-1.476*	-1.406*	-1.469*	-1.365*
$\epsilon 22$	-2.371*	-2.374*	-2.413*	-2.358*	-2.368*	-2.355*
$\epsilon 33$	-1.240*	-1.232*	-1.311*	-1.305*	-1.272*	-1.182*
$\epsilon 44$	-0.754*	-0.778*	-0.754*	-0.754*	-0.729*	-0.839*
$\epsilon 55$	-1.492*	-1.525*	-1.429*	-1.498*	-1.510*	-1.438*
Cross Price Elasticity						
$\epsilon 12$	-0.063	-0.058	-0.057	-0.092	-0.017	0.158
$\epsilon 13$	0.539*	0.556	0.528	0.560	0.527	0.409
$\epsilon 14$	0.113	0.109	0.186	0.095	0.067	-0.176
$\epsilon 15$	0.615	0.715	0.637	0.628	0.649	0.207
$\epsilon 21$	-0.048	-0.042	-0.035	-0.077	-0.009	0.081
$\epsilon 23$	-0.633*	-0.634*	-0.664*	-0.631*	-0.634*	-0.624*
$\epsilon 24$	0.754*	0.767*	0.918*	0.771*	0.751*	0.381*
$\epsilon 25$	1.060*	1.037*	0.977*	1.072*	1.017*	1.603*
$\epsilon 31$	0.918*	0.938*	0.897*	0.949*	0.897*	0.776*
$\epsilon 32$	-0.771*	-0.777*	-0.827*	-0.769*	-0.769*	-0.619*
$\epsilon 34$	-0.127	-0.136	-0.286	-0.123	-0.100	0.509*
$\epsilon 35$	-0.297	-0.293	0.041	-0.286	-0.270	-1.378
$\epsilon 41$	0.342*	0.338*	0.378*	0.335*	0.310*	0.162
$\epsilon 42$	0.568*	0.571*	0.633*	0.575*	0.563*	0.456*
$\epsilon 43$	0.073	0.072	0.037	0.075	0.075	0.177*
$\epsilon 45$	2.574*	2.570*	2.374*	2.564*	2.619*	3.277*
$\epsilon 51$	0.230**	0.254*	0.222**	0.232**	0.232**	0.138
$\epsilon 52$	0.321*	0.312*	0.280*	0.322*	0.312*	0.571*
$\epsilon 53$	-0.103	-0.101	-0.047	-0.102	-0.100	-0.320*
$\epsilon 54$	1.113*	1.107*	0.931*	1.100*	1.155*	1.763*

* Significance assumed at $P \leq 0.05$
** Significance assumed at $P \leq 0.10$
Where for ϵij, i takes the values: 1-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, 5-Generic

Table 10: 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						
$\epsilon adv11$	2.50E-05	2.51E-05	2.47E-05	2.55E-05	2.72E-05	4.88E-05*
$\epsilon adv12$	-2.16E-	-2.19E-05*	-2.18E-05*	-2.16E-05*	-2.20E-05*	-2.48E-05*
$\epsilon adv13$	-1.94E-	-1.97E-03**	-1.92E-03*	-1.96E-03*	-1.97E-03*	-2.88E-03*
$\epsilon adv21$	7.71E-06	7.74E-06	3.26E-06	7.38E-06	8.40E-06	1.46E-05
$\epsilon adv22$	-1.28E-05	-1.27E-05	-1.21E-05	-1.28E-05	-1.29E-05	-1.65E-05
$\epsilon adv23$	-1.89E-05	-3.15E-05	1.08E-04	-2.00E-05	-3.39E-05	-2.19E-04
$\epsilon adv31$	7.52E-06	7.24E-06	1.03E-05	7.79E-06	6.49E-06	-4.09E-06
$\epsilon adv32$	4.70E-06	4.52E-06	4.03E-06	4.67E-06	4.69E-06	9.68E-06
$\epsilon adv33$	5.89E-04	6.03E-04	4.16E-04	5.82E-04	6.39E-04	1.07E-03
$\epsilon adv41$	-3.44E-05	-3.41E-05	-3.32E-05	-3.45E-05	-3.60E-05	-4.47E-05
$\epsilon adv42$	2.28E-05*	2.31E-05*	2.34E-05*	2.28E-05*	2.32E-05*	2.44E-05*
$\epsilon adv43$	3.82E-03*	3.84E-03*	3.82E-03*	3.81E-03*	3.79E-03*	4.18E-03*
$\epsilon adv51$	1.54E-05	1.53E-05	1.78E-05	1.56E-05	1.40E-05	3.97E-06
$\epsilon adv52$	-3.56E-06	-3.59E-06	-4.44E-06	-3.58E-06	-3.51E-06	-1.64E-08
$\epsilon adv53$	-1.51E-	-1.50E-03*	-1.63E-03*	-1.51E-03*	-1.44E-03*	-9.94E-04*

* Significance assumed at $P \leq 0.05$
** Significance assumed at $P \leq 0.10$
Where for $\epsilon adv\ ij$, i takes the values: 1-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, 5-Generic

Table 11: 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						
ϵp1(p2)	-0.015	-0.014	-0.012	-0.025	-0.001	0.053
ϵp1(p3)	0.200*	0.211*	0.187*	0.208*	0.185*	0.146*
ϵp1(p4)	0.061	0.060	0.082	0.055	0.036	-0.074
ϵp2(p4)	0.212	0.248**	0.207	0.216	0.204	0.050
ϵp2(p1)	-0.009	-0.008	-0.008	-0.015	0.000	0.033
ϵp2(p3)	-0.133*	-0.133*	-0.150*	-0.133*	-0.133*	-0.126*
ϵp2(p4)	0.163*	0.164*	0.206*	0.166*	0.163*	0.121*
ϵp2(p5)	0.192*	0.186*	0.183	0.194*	0.185*	0.342*
ϵp3(p1)	0.304*	0.315*	0.283*	0.341*	0.287*	0.220*
ϵp3(p2)	-0.335*	-0.339*	-0.337*	-0.361*	-0.327*	-0.307*
ϵp3(p4)	-0.157	-0.158	-0.202	-0.168**	-0.145	0.010
ϵp3(p5)	-0.234	-0.231	-0.115	-0.250	-0.223	-0.675*
ϵp4(p1)	0.024	0.023	0.033	0.021	0.018	-0.029
ϵp4(p2)	0.106*	0.105*	0.124*	0.108*	0.128*	0.075*
ϵp4(p3)	-0.041	-0.040	-0.054*	-0.040	-0.047	0.003
ϵp4(p5)	0.452*	0.444*	0.379*	0.447	0.569*	0.681*
ϵp5(p1)	0.039	0.044**	0.046	0.040	0.039	0.009
ϵp5(p2)	0.059*	0.057*	0.060*	0.059*	0.056*	0.099*
ϵp5(p3)	-0.028**	-0.027**	-0.017	-0.028**	-0.027**	-0.028*
ϵp5(p4)	0.211*	0.211*	0.206*	0.211*	0.218*	0.316*
ϵp1(mc)	0.182***	0.167*	0.182***	0.182***	0.182***	0.182***
ϵp2(mc)	0.178***	0.178***	0.160*	0.178***	0.178***	0.178***
ϵp3(mc)	0.185***	0.185***	0.185***	0.160*	0.185***	0.185***
ϵp4(mc)	0.207***	0.207***	0.207***	0.207***	0.170*	0.207***
ϵp5(mc)	0.173***	0.173***	0.173***	0.173***	0.173***	0.111*

* Significance assume at $P \leq 0.05$.
** Significance assume at $P \leq 0.10$.
***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-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, 5-Generic.

4.3 Model Selection

The literature has approached the selection of an appropriate model from a host of choices in a variety of ways. Vuong (1989) illustrates an in-depth selection criteria by presenting likelihood ratio tests for non-nested hypothesis testing. Simpler approaches also using 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 as the one with the lowest sum of squared errors (Kadiyali, Vilcassim, and Chingtagunta, 1996).

In selecting the appropriate model for Canadian and Australian markets, concern exists about how well predicted prices approach observed prices. The squared differences between observed and predicted prices can be interpreted as squared errors. Summing these squared errors from each price equation it is possible to calculate a sum of squared errors. The model with the lowest sum of squared errors is thus interpreted as the best model. The next two tables illustrate the sum of squared errors by price equation and in total.

Table 12: Sum of Squared Errors for Canadian Fresh Chicken Bertrand-Nash and Stackelberg Models by Price Reaction Equation and in Total

	Lilydale operates as IOF				Lilydale operates as producer cooperative				
			Market participants treat Lilydale as IOF			Market participants treat Lilydale as IOF		Market participants treat Lilydale as producer cooperative	
	Bertrand	Stackelberg Lilydale	Stackelberg Maple Leaf	Stackelberg Generic	Bertrand	Stackelberg Maple Leaf	Stackelberg Generic	Stackelberg Maple Leaf	Stackelberg Generic
Price reaction Equation									
Lilydale	558.1	8226.1	19676.6	513.4	15.1	15.1	15.1	15.1	15.1
Maple Leaf	637.9	1130.9	20624.2	590.0	533.4	6873.4	506.2	540.5	531.2
Generic	22.4	19.5	23.4	23.4	28.9	26.4	31.1	28.9	29.3
Total	1218.4	9376.6	40324.2	1126.8	577.4	6914.9	**552.4***	584.5	575.6

*Preferred model

Table 13: 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

In Canadian and Australian markets we reject Bertrand-Nash behavior and confirm the identity of a Stackelberg leader. In Canada, the leader is generic (with Lilydale acting as a producer cooperative but being treated as a IOF) while in Australia, Pace Farms leads.

In Canada, the selection of a preferred model solely by lowest sum of squared errors may seem rather arbitrary given that three other models also express sum of squared errors in the mid to upper five hundred mark. These models include the Bertrand Nash model where Lilydale acts like a producer cooperative, and the Maple Leaf and Generic Stackelberg models where Lilydale acts and is treated as a producer cooperative. Therefore to support the selection of the preferred model market information is also used. Given that generic commands 94% of the Canadian market, it seems logical that it may determine market trends as the Stackelberg leader. By processes of elimination this removes the Bertrand and Maple Leaf Stackelberg models. Between the remaining two Generic Stackelberg models one must decide between the situation where Lilydale is treated as an IOF or a producer cooperative. In this decision cooperative theory favors the Generic Stackelberg model where Lilydale is treated as an IOF. As a producer cooperative, Lilydale should practice marginal cost pricing in order to maximize member welfare. However, Lilydale often charges the highest market price. As a cooperative, in order to regularly charge prices above other market participants, Lilydale must observe much higher marginal costs. This is doubtful given the availability of similar processing technology and similar producer prices. Therefore, their demands for higher prices are seen by other market participants as actions similar to an IOF which may be attempting to maximize profits rather than member welfare. Remember, of course, that member welfare includes profits and producer surplus.

To further support model selection, it is useful to investigate parameter estimates and their congruency with economic theory. From economic theory, two readily applied parameter constraints revolve around negative own-price elasticities and positive own-product advertising elasticities. Since the sign and magnitude of these elasticities are largely determined by parameter estimates it is important that parameter estimates have the appropriate sign. For own-price elasticities to be negative, the sign of the own-price parameter (γ_{ii}) must be negative. In all models for both Canada and Australia, own-price parameters readily conform to this constraint by yielding negative own-price elasticities. As such own price parameters present no innate bias against any particular model. For own-product advertising elasticities to be positive own-product advertising parameters (λ_{ii}) must also be positive. In Appendix 4 tables A11 to A16 it is clear that Pace Farm's own-price advertising parameter across all models is negative. Calculating own-product advertising elasticities with these parameters results in negative own-product elasticities. From theory, this is counter intuitive because it suggests that as advertising expenditure increases consumers purchase less. Theory may suggest diminishing returns to advertising but in few circumstances does it suggest negative relationships. However, the lack of parameter and elasticity significance prevents these theoretically incongruent results from creating model bias.

4.4 Model Selection and Processor Strategic Interaction

The selection of the best fitting model for a particular market necessitates the rejection of Bertrand-Nash behavior in both Australia and Canada. The market data indicates that, in terms of volume and value, generic processors in Canada lead the market, while in Australia private label and generic processors lead the market. However, the best fitting model suggests that Pace Farms leads in Australia while generic leads in Canada. Additionally in Canada the preferred model has Lilydale acting as a cooperative but other market participants still treat Lilydale as an IOF. While these games may be the preferred model, 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 price reaction and set their prices accordingly. Followers observe the leader's decision and set prices in a reactionary fashion. This dynamic relationship may seem counterintuitive 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 outcomes (Axelrod, 1982; Kreps, 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. These researchers speculate 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.

A second explanation for observing Stackelberg behavior may be multimarket contact (Bernhein and Whinston, 1990). 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. 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. 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 signaling 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 (Hoteling,1927) suggests that firms should position products as far away from competing products in order to serve different market segments. The largest brand then 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. Evidently rivals must match price decreases 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, 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 viewed as more readily competing with each other. Given the illustrated elasticities, choice of appropriate product positioning strategy 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 its product from others through selective feeding programs. Their vegetable-grain-fed birds are readily marketed as an alternative to conventional chicken, which is readily produced on rations that may contain animal by products. As such they 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, readily displays the converse assumption, assuming that head-to-head product interaction reduces competition. Given that Pace Farms displays the highest own-price elasticity they cannot readily claim to be a differentiated product. However, examining retail prices Pace never is the highest priced item, nor is it the lowest. It remains competitively price in relation to other products. In contrast, 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 readily has the highest retail price. Observing a lower price elasticity private label has been able to substantially cut prices starting in the fourth week of 2000 and has made huge market gains largely at the expense of generic. Positioning itself as the low cost industry leader has allowed private label to exploit its lower own-price elasticity and make huge gains in volume and value.

To investigate cross-price elasticity relationships the following two tables summarize Marshallian elasticities for our preferred models. The illustration of Marshallian elasticities reveals the gross affect of both consumer substitution and incomes effects. The following discussion interprets gross demand. Elasticities not significant at $P \leq 0.10$ are assumed to be zero.

Table 14: Summary of Significant Marshallian Elasticities for Canadian Fresh Chicken Stackelberg-Generic Model where Lilydale Acts as a Cooperative but is Treated as an IOF

	Demand for:		
	Lilydale	Maple Leaf	Generic
Price of:			
Lilydale	-1.304	.333	-0.017
Maple Leaf	2.190	-0.698	0
Generic	-1.178	0	-1.080

Significance assumed at $P \leq 0.10$

Table 15: Summary of Significant Marshallian 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

Significance assumed at $P \leq 0.10$

Both positive and negative cross price elasticities are observed for Canadian and Australian markets. Non-significant results as illustrated by zero cross-price elasticities, illustrate no relationship between products. Given the assumption of rational firms, a requirement for profit maximizing firms is the observation of positive cross price elasticities. 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 positively 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 positively sensitive to private label. This is an essentially detrimental position given that private label is actively pursuing a price cutting strategy. 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's cross price elasticities make it proportionality more sensitive to the other major branded product, Maple Leaf, than Maple Leaf is to it. They have positioned themselves as the more price sensitive branded product yet regularly charge the highest price.

To further investigate the relationship between goods, Hicksian demand elasticities are also considered. 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 when Marshallian demand elasticities are used. In all cases, wherever a negative Marshallian ε_{ij} is observed, there is a corresponding negative ε_{ji}. As such the goods are seen 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 Lilydale and generic, Farm Pride and Pace Farms, Farm Pride and private label, and Farm Pride and generic. However, the use of Marshallian demand elasticities combines both substitution and incomes effects. If one were to separate out only the substitution effect than Hicksian demand elasticities should be used. In tables 16 and 17 Hicksian demand elasticities for the preferred models are presented.

Table 16: Summary of Significant Hicksian Elasticities for Canadian Fresh Chicken Stackelberg-Generic Model where Lilydale Acts as a Cooperative but is Treated as an IOF

	Demand for:		
	Lilydale	Maple Leaf	Generic
Price of:			
Lilydale	-1.294*	0.348	0
Maple Leaf	2.251*	-0.602*	0.066
Generic	0	0.787	-0.207*

Significance assumed at $P \leq 0.10$

Table 17: Summary of Significant Hicksian Elasticities for Australian Eggs Stackelberg-Pace Farms Model.

	Demand for:				
	Sunny Queen	Pace Farms	Farm Pride	Private Label	Generic
Price of:					
Sunny Queen	-1.476	0	0.897	0.378	0.222
Pace Farms	0	-2.413	-0.827	0.633	0.280
Farm Pride	0	-0.664	-1.311	0	0
Private Label	0	0.918	0	-0.754	0.931
Generic	0	0.977	0	2.374	-1.429

Significance assumed at P ≤0.10

It is easily seen that only Farm Pride and Pace farms remain as gross and net complements. Other previously assumed gross compliments, Lilydale and generic, Farm Pride and private label, and Farm Pride and generic, exhibit no net substitution affect. Therefore, their gross substitution effect can be attributed to an income effect rather than a substitution effect.

In Canada, the elasticity examination illustrates Maple Leaf 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-feeding production and promotion program has actively carved out a market niche allowing them 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, which makes it more sensitive to Maple Leaf than Maple Leaf to them, and a negative cross-price elasticity relationship 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 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 advances 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.

4.5 Summary

Using TSP software empirical estimates of the theoretical models were estimated. The preferred models favor Stackelberg relationships over Bertrand Nash Competition. In Canada, generic is the Stackelberg leader while in Australia Pace Farms is the Stackelberg leader. The preferred Canadian model also illustrates that while Lilydale acts as a producer cooperative, market participants still treat them as an IOF. Marshallian and Hicksian demand elasticity evaluation illustrate a considerable income effect. Gross complement goods such as Lilydale and generic, Farm Pride and private label, and Farm Pride and generic are seen as net substitutes once the income effect is removed. Ultimately elasticity evaluation illustrates that market conditions are sensitive to the selection of the preferred model.

5.0 Synthetic Model: Assessing Generic Advertising and Research

The proper identification of participant conduct can be a very useful tool. It is particularly interesting to consider investment returns under the identified market structure and participant conduct. In primary production industries such as farming, two readily advocated investments include generic advertising and/or research and development. This holds true for the Canadian chicken and Australian egg markets. In both markets the potential impact of generic advertising and research is widely debated. Some lobby groups, after observing the success of generic advertising campaigns in other industries, widely advocate the implementation of a national generic advertising program. Such groups focus on market demand as a method to increase producer returns; in contrast others advocate investments in research. Investments in research are sought to lower production costs thus allowing producers to more efficiently supply market demands. This strategy focuses on technological change and supply shifts as a means to improve producer welfare.

In the literature, the success of generic advertising and research seems to be situational. Using the United States beef, pork and chicken meat industries as an example of generic advertising investments, Brester and Schroeder (1995) observe a variety of responses to both generic and brand advertising. Measured in terms of elasticities they indicate that US beef demand changes by 0.006% for every percent change in generic advertising while beef brand advertising is slightly more responsive at 0.007. Pork advertising elasticities range from -0.0005 for generic advertising to 0.033 for brand advertising. In Brester and Schroeder's study, chicken advertising data is not separable into brand and generic, however, chicken is shown to exhibit an advertising elasticity of 0.0047 to the total accumulated chicken advertising. It seems that conservative estimates of advertising elasticity responsiveness are in the range of 10^{-3}. Similarly, investments in research regularly produce returns on investment of approximately 60% and elasticities in the 10^{-3} range (Alston, Marra, Pardey, and Wyatt, 2000; Zachariah, Fox, and Brinkman, 1989.) Given the debate about generic advertising and research effectiveness, this research investigates the market implications for conservative estimates of generic advertising and research effectiveness.

5.1 Synthetic Model Development

To assess the potential impact of generic advertising and research in the Canadian and Australian markets, this study uses a synthetic model to vary advertising and research investments. The effectiveness of these investments is derived through comparison to a base model. First, it is necessary to illustrate the development of the synthetic model before we discuss the base model and synthetic model simulations.

In the synthetic model, a linear demand system incorporating symmetry and generic advertising is used. Demand equations expressed in general form are

$$q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} p_j - \frac{\lambda_g}{adv_g} \tag{5.1}$$

where for processor i q, p ,and adv_g, represent quantity, price, and generic advertising. γ_{ij} and λ_g are parameter coefficients for price and generic advertising. The model utilizes demand elasticity estimates from the preferred model in each market to derive price parameter estimates. For example the demand elasticity calculated at the mean is

$$\varepsilon_{ij} = \frac{\partial p_i}{\partial q_j} * \frac{\bar{q}_j}{\bar{p}_i} \tag{5.2}$$

Parameter estimates are then calculated by

$$\gamma_{ij} = \frac{\partial p_i}{\partial q_j} = \varepsilon_{ij} * \frac{\bar{p}_j}{\bar{q}_i} \tag{5.3}$$

Given parameter estimates, intercept terms are calculated by

$$\alpha_i = q_i - \sum_{i=1}^{n} \gamma_{ij} p_j + \frac{\lambda_g}{adv_g} \tag{5.4}$$

To simulate the processor conduct, price reaction functions (specific to the preferred model in each market) are also included. These follow the form previously illustrated in model development and include $X_i = -\frac{\lambda_g}{adv_g}$. Price reaction equations also included a constant. The constant was calculated as the difference between the actual price and the price calculated by the parameters derived from the demand equations. These constants where used to calibrate the model to yield initial starting values. An alternative method to calibrate the model would be to simultaneously solve the demand parameters in both the demand and price reaction equations. This proved exceedingly difficult given that some parameters often were squared terms. As such the complicated algebra was determined to be beyond the scope of this research and the simpler method was adopted. For an additional element of realism in the model, supply equations were also included. Supply equations are also required for the investigation of research effectiveness. The supply equations were specified as linear functions of quantity and can be represented as follows:

$$fp = h + g * q_t + jR_i \tag{5.5}$$

where fp represents producer price, q_t represents the sum of all producer production, R_i represents investment in research, and h, g and j are estimated parameters. Similar to demand equations supply elasticities were used to derived parameter estimates. For Australian eggs, it was possible to estimate a supply elasticity for a period similar to the empirical estimation of the preferred model by regressing total quantity of production on producer prices. Estimation statistics are available in Appendix 4, Figure A15. Australia's supply elasticity was estimated at 1.001. For Canadian chicken the supply estimation was not possible for an over-lapping period. Given that Canada's industry is a supply managed industry, supply equation estimation requires the use of quota values in addition to quantities. Weekly quota value estimates were unavailable for the period of the study. Instead a historical annual supply elasticity estimation of 0.299 was used (Zachariah, Fox, and Brinkman, 1989). It should be noted that the backward derivation of demand and supply parameters from elasticities were calculated for a base model and then held constant in other models where advertising and research investment were varied.

In order to introduce real life variability and error Monte Carlo simulations where completed. These simulations where used to calculated 95% confidence intervals. These confidence intervals allow one to better understand the likelihood of an occurrence. In this research Monte Carlo simulations were completed by including error terms on both the advertising and research parameters. These errors where randomly generated from a normal distribution with a mean of zero and a standard deviation of 0.004 for advertising and 0.003 for research. These estimates of standard deviation are utilized from previous research as presented by Brester and Schroeder (1995) and Alston, Marra, Pardey, and Wyatt (2000). Simulations where replicated 1000 times. From these replictaions, both mean quantity and prices predictions, as well as confidence intervals can be calculated. Table A17, Appendix 4 illustrates a summary of the equations estimated in each synthetic model.

5.2 Base Model and Synthetic Model Simulations

The base model in both markets is used as a basis for comparison. It assumes initial prices, quantities, generic advertising investment, research investment, as well as advertising and research elasticities. Initial prices and quantities are indicated in appendix 4 figures A18 and A26. Initial investments in advertising and research are set at $500,000 apiece and initial advertising and research elasticities are set at 0.005. Initials investments of $500,000, solely funded by producers, represent a check-off of $0.002/kg for Canadian producers and $0.005/dozen for Australian producers

Given this base model, four simulations for each market were considered. Each simulation increased either generic advertising or research investment by 50% or 100%. Since these simulations consider similar investments, it is possible to compare the effectiveness of investments in generic advertising versus research. Synthetic model simulation results are presented in Appendix 4, Figures A18 to A33. Discussion of results proceeds in the next section.

5.3 Investment in Generic Advertising versus Research

In the synthetic model, investments in both generic advertising or research were considered. Initially, a base model is assumed to produce parameter estimates. Given these conditions, increasing levels of advertising and research are individually considered as they affect both producers and processors alike.

From a producer point of view investments in generic advertising are seen to be solely beneficial to Canadian producers, investment in generic advertising in Australia or research in either country is counterproductive (Tables A20, A21, A28 and A29). In Canada the success of advertising investment is largely due to the increase in quantity marketed as farm prices remain relatively stagnant (Table A18). The increase in quantity more than offsets the increase investment expenditure. Conversely in Australia investment in advertising has less effect on quantities; similar to Canada farm prices remain stable (Table A26). The increase in quantity is not great enough to compensate for the increase investment expenditure. When considering returns to research, both Canada and Australia reflect negative returns on investment (Table A21 and A29). While investment in research does spur on quantity growth, it has an opposing effect on farm price. The increase in quantity marketed is not substantive enough to offset decreasing farm prices and increasing investment expenditure. As a result, advertising investment is beneficial only in Canada, while research investment is negative in both countries. In both Canada and Australia, the optimum level of advertising was not investigated. In reality, if one considers prices and quantities as strategic variables in oligopoly markets, one must also consider advertising as a strategic variable. Therefore, the optimum level of advertising for producers may also be a function of the branded advertising strategies followed by processors. The suggestion of advertising games must also consider previous discussion on branded and generic advertising as exhibiting either cooperative or antagonistic relationships.

In the above paragraph, generic advertising and research was investigated from a producer perspective, but how do these investment affect processors. This discussion arises largely from arguments concerning investment responsibility. If processors and producers both benefit from investments in generic advertising or research, then processors too have incentive to fund advertising investment. This has been speculated by some producer groups as a means to offset producer investment costs. In Canada processor returns marginally improve from investments in advertising and are a wash when considering investments in research (Table A22). In Australia investment in both advertising and research has marginal influence. Increases and decrease in return over base cases can again be considered a wash. The success of advertising for Canadian processors is due to increasing retail prices and quantities. These gains are large enough to offset rising marginal costs (Table A18). When considering research investment in Canada or advertising and research investment in Australia the gains in quantity and retail price is not large enough a produce positive return for all processors. Rising marginal cost influences some processors more than others and produce negative returns. As a result processor incentive to invest in generic advertising or research is marginal. If processors were forced to participate the slight improvement in returns that some observe, may quickly be overcompensated for by increased costs. As a result producers can suggest little substantive evidence for processors to participate in either generic advertising or research.

It is noted that in the investigation of both produce and processor returns the confidence intervals seem relatively narrow. It Appendix 4, Table 34 an ad hoc analysis of Canadian fresh chicken illustrates the span of confidence intervals to be directly related to the assumed standard deviation used in each synthetic model. The narrow confidence intervals observed in this research are likely due to the small parameters rather than the assumed standard deviation.

As a side investigation, processor markets shares were also examined were also examined (Tables A24, A25, A32, and A33). In this investigation market shares are seen to be static . They do not fluctuate from either investments in generic advertising or research. This follows largely by assumption. In the synthetic model simulation only one advertising and one research elasticity were assumed. This means that changes in either affect all processors similarly. Further research may propose multiple elasticities, unique to each processor, to further investigate market share distortions.

5.4 Summary

Synthetic models were created to investigate investment in both generic advertising and research and development. While producers in Canada are shown to favor investment in advertising, no consistently positive results are achieved for research in Canada or advertising and research in Australia. Processors in both countries remain only marginally influenced by either. Standard deviation sensitivity analysis illustrates that confidence intervals may remain relatively narrow because of the small parameters used in the simulation, rather than the choice of standard deviation.

6.0 Conclusion

6.1 Research Conclusions

In the Canadian fresh chicken and Australian egg markets increasing processor and retailer concentration is having dramatic effects on market equilibrium. This increasing concentration clearly illustrates a market more readily modeled by theories of non-cooperative oligopolies then perfect competition. In such models, market structure and participant conduct are shown to influence not only the size of returns but also the distribution of returns. Given this observation, this research empirically estimates processor strategic interaction and then utilizes these results to assess producer investments in both generic advertising or research and development.

Here, the empirical model first assumes that the Canadian and Australian markets are vertical market channels with few intermediary participants i.e. processors and retailers. Intermediaries are thought to strategically compete with competitors knowing full well that their optimal strategy is not only dependent on their decisions but also on the decisions of fellow competitors. Given only retail level data, processor strategic action was abstracted from retail information by assuming a constant market-up policy followed by retailers. Processors were assumed to exhibit either Bertrand Nash or Stackelberg relationships. Bertrand Nash interaction assumes that each processor optimizes their own price with respect to their own profit function. Conversely Stackelberg interaction assumes that a leading firm uses foresight to predict a follower firm's action and then incorporates this information into its optimum pricing decision. Given these two alternative actions, preferred models were selected from a menu of choices. In Canada, three processors were considered: Lilydale, Maple Leaf, and generic. In Australia five processors were considered: Sunny Queen, Pace Farms, Farm Pride, Private Label, and generic. In both markets, Bertrand Nash behavior was rejected in favor Stackelberg behavior. In Canada generic emerged as the market leader, while in Australia Pace Farms emerged as the leader.

In addition to participant strategic action, empirical investigation in Canada also considered the structure of competing firms. In Canada two types of firms are observed: IOFs and cooperatives. While the objective of an IOF is to maximize profits the objective of a cooperative is to maximize producer welfare and profits. As such, the optimum action for either may be different. Given these differing objective functions, a multitude of scenarios were considered. The first scenario treated Lilydale and all competitors as IOFs. The second scenario had Lilydale act as a cooperative but other market participants still treated them as either an IOF or cooperative. The third scenario had Lilydale act and be treated as a cooperative. The preferred model illustrates that while Lilydale acts as a cooperative, other firms still treat them as an IOF. The idea that other market participants may treat a cooperative firm as a IOF, in spite their declaration of cooperative intent, is seen a unique extension in this research and as an advancement in theoretical reasoning. As such, the preferred model in Canada has generic as a Stackelberg leader who treats Lilydale as an IOF despite the fact that Lilydale acts like a cooperative. In both the Canadian and Australian markets the preferred empirical models provide the basis for the synthetic model. The synthetic model is used to access producer investments in generic advertising or research and development.

In the synthetic model, a system of demand equations, price reaction equations, and farm supply equations were estimated. These equations provided opportunity to include both generic advertising and research investment. Elasticity estimates from the preferred models were used to derive demand equations parameters. In Canada, supply equation parameters were derived from historical elasticity estimates, while in Australia an estimated farm supply equation provided supply elasticities used to derive supply parameters.

In Canada generic advertising was shown to be preferred by producers. Generic advertising in Canada or generic advertising and research in Australia presents little benefit for producers inducing negative returns. Processors were shown to be only marginally affected by investments in either and furthermore observed no real incentive to participate in funding generic advertising or research activities. No distortion of market share was noticed between processors.

Overall this research highlights the importance of market structure and participant conduct assumptions. Both are shown to readily influence market outcomes and distribution of investments. Future research in concentrated markets will undoubtedly require similar approaches in order to properly account for market dynamics.

6.2 Suggestions for Further Research

The intense investigation and research performed here has often suggested opportunity for improvement and further research. The following are a few suggestions for further research.

1. A major assumption used during estimation of the preferred model and market conduct relied on the assumption of market structure. Given the available data, the horizontal games played between processors were illustrated in a vertical market channel. Interaction was abstracted from retail data by assuming a fixed retail markup policy. While this allowed for the investigation of horizontal processor games, a better model, more representative of current market conditions, would also include the retailer action. This approach adopted by Cotterill (2000), Choi (1991), Dhar and Cotterill (2002), and Liang (1987), allows retailer strategic action to influence market outcomes. In such research, two approaches have been used. Cotterill (2000) allows processor action to be illustrated as a vertical game modeled through retailer horizontal action while Choi (1991) assumes a wider range of vertical structures to asses retailer and processor relationships. Advancements to this research would include the simultaneous estimation of both horizontal retailer and horizontal producer games under a multitude of vertical relationships. The disagreement regarding the use of different estimation techniques, i.e. menu approach, conjectural variation, times series causal tests, can be though of as secondary in nature as compared to proper specification of market structure and conduct. To further expand market structure research, one may also consider the simultaneous estimation of supply equations.

2. The inclusion of Lilydale, and therefore cooperative objective functions, includes a dynamic element not readily included in most market research and even less in oligopoly market research. While it is found that Lilydale acts like a cooperative instead of an IOF, their debatable success raises questions about whether the existence of a cooperative actually benefits producers. While the fundamental theory suggests that all producers are better off if even one cooperative exists this statement has not been empirically estimated in the Canadian market or in other similar markets. With proper understanding of market structure and conduct, the question of cooperative effectiveness can be investigated with more accuracy.

3. The majority of oligopoly research has largely focused on game and market structure specification. As a result one finds that demand estimation is far less advanced.

One particular area of interest, largely developed for demand analysis and readily applicable to oligopoly research, regards testing for structural change. The investigation as to the stability of strategic action adds a dynamic element to this area of research that has not been investigated. This idea is largely derived from examining the Australian egg market. While Pace Farms is illustrated to be the Stackelberg leader, the aggressive price cutting strategy by private label product, which resulted in large sales increases, suggests another dominant strategy in the market. Parametric or the favored non-parametric (Alston and Chalfant, 1991) tests for structural change could greatly assist in the determination of game stability.

4. This research assumes that investments in generic advertising affects each processor similarly. Further research can expand upon this by incorporating varying rates of advertising responsiveness and cross equation advertising effects. This may more accurately depict true market conditions and would allow for further investigation of market share distribution as games are continually played out.

5. The idea that cooperatives may be treated as IOF, despite declaration of cooperative intent, is an advancement in theory reasoning and empirical assessment. Such an approach has not been documented in previous research and is seen as a first in this research. Accounting for the dynamics of participant action is a consistent theme in game theory and is only expanded by including the variety of scenarios cooperative objective functions present.

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Appendix 1

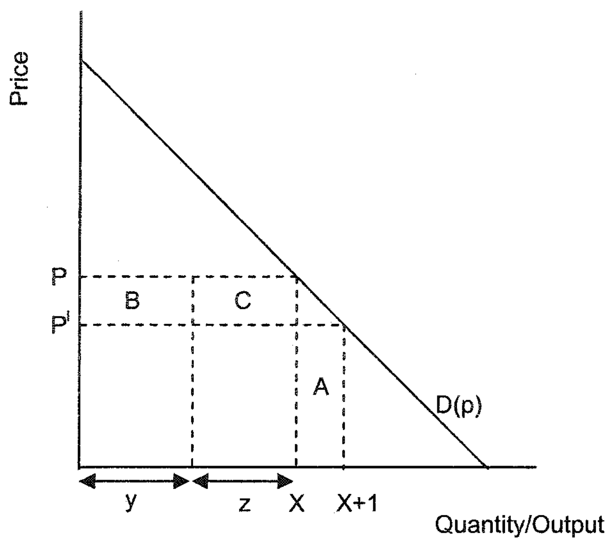
Table A1: Fundamental Assumptions and Structure of Competition Models

Characteristic	Market Structure Monopoly	Oligopoly	Monopolistic Competition	Perfect Competition
Buyer Influence on Price	Buyers are price takers	Buyers are price takers	Buyers are price takers	Buyers are price takers
Seller Influence on Price	Seller is a price maker	Sellers are price makers	Sellers are price makers	Sellers are price takers
The Size and number of Buyers	Many buyers, no one of which is large relative to the overall market.	Many buyers, no one of which is large relative to the overall market.	Many buyers, no one of which is large relative to the overall market.	Many buyers, no one of which is large relative to the overall market.
The Size and Number of Sellers	One Seller	Few Sellers, each of which is large relative to the overall market.	Many Sellers, no one of which is large relative to the overall market	Many Sellers, no one of which is large relative to the overall market
Extent of Strategic behavior/Interdependence	Seller does not behave strategically. Only firm in market, not concerned about competitors	Sellers behave strategically. Interdependent, strategic pricing and output decisions.	Sellers do not behave strategically. Each firm acts independently.	Sellers do not behave strategically. Each firm act independently.
The degree of Substitutability among Different Seller's Products	There are no close substitutes	The outputs of different sellers may or may not be differentiated.	The output of different sellers are heterogeneous	The output of different sellers are homogeneous.
The Extend to which buyers are Informed about Prices and Available Alternatives	Buyers are well informed about the offerings of competing suppliers.	Buyers may or may not be well informed about the offerings of competing suppliers.	Buyers may or may not be well informed about the offerings of competing suppliers.	Buyers are well informed about the offerings of competing suppliers.
Conditions of Entry	Entry into the market is completely blocked. Either Technological or legal Barriers completely block entry	Entry into the market may be blocked or free. Technological or legal Barriers to entry exists may or may not exist.	Entry into the market is free. Neither technological or legal Barriers to entry exist.	Entry into the market is free. Neither technological or legal Barriers to entry exist.
Profit	Possibility of long-run economic profit.	Some long-run economic profit possible.	No long-run economic profit possible.	No long-run economic profit possible.

(Katz and Rosen, 1998; Colander and Sephton, 1996)

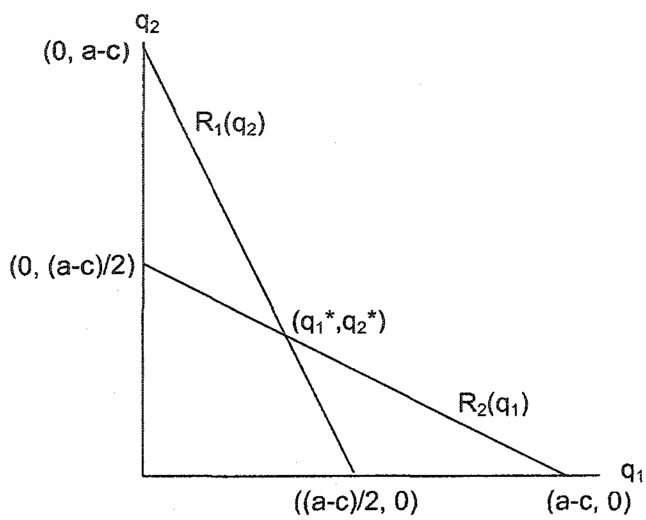
Appendix 2

Figure A1: Incentives to Cheating in a Cartel.



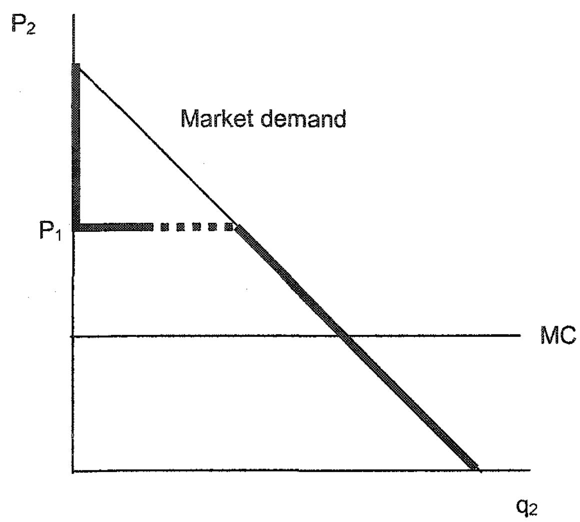
Using an adaptation of an example presented by Katz and Rosen (1998) let us suppose that there is an industry with only two firms, y and z. The industry demand is represented by the function D(p). The two firms decide to collude and form a cartel. They maximize joint profits by restricting quantity of X and charging price P, of which they split equally. If one firm, suppose firm y, decides to cheat and market one more unit of output the industry marginal revenue response can be broken into three parts labeled A,B, and C respectively. The first response, A, is the gain in revenue for firm y from selling an addition unit of output. The second response, B, is a revenue loss because the increase in industry output lowers the price received by firm y for the tickets it was selling before the output change. Finally the third response, C, is a revenue loss because the increase in industry output lowers the price received by firm z for the tickets it was selling before the output change. Since firm y cares only about its only profit it is not concerned with the marginal loss, area C, firm z receives as industry output increase. If its marginal gain, area A, is greater than its marginal loss, area B, firm y has incentive to cheat in the agreement. Since both firms are assumed to be symmetrical the same reasoning can be used to illustrate incentive for firm z to cheat. Additionally the incentive to cheat is directly related to the elasticity of the market demand. The more inelastic the demand is, the steeper the demand curve. Therefore, for any given price change, the quantity response will be less. The marginal gain, area A, may not be enough to offset the firm specific marginal loss, area B or C. The opposite is true for more elastic demands.

Figure A2: Graphic Illustration of Cournot-Nash Equilibrium given Duopoly Competition.



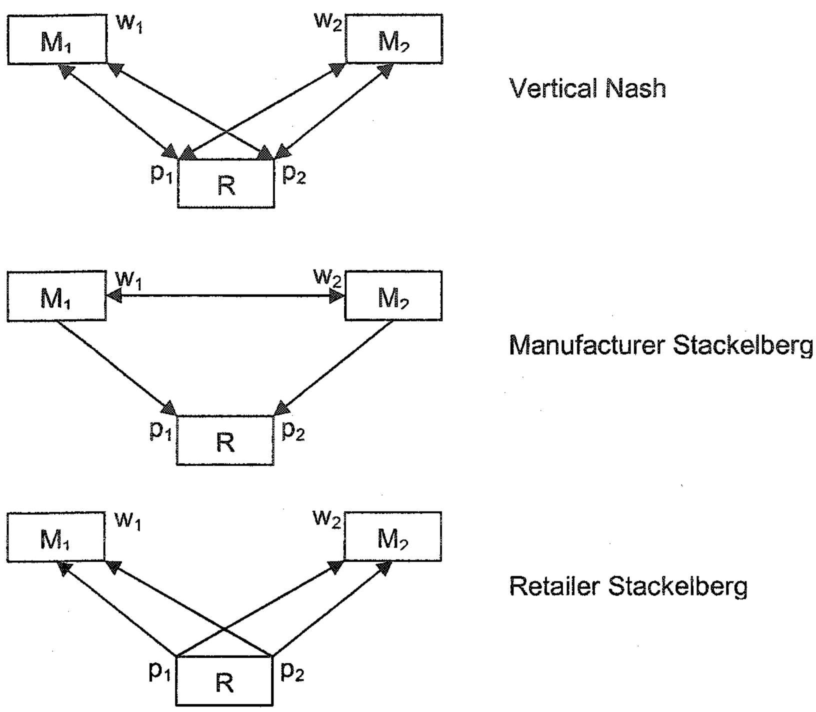
Given Cournot/quantity competition in a Duopoly market firm, 1's optimal choice given firm 2's output is illustrated by the reaction function $R_1(q_2)$. Firm 2's optimal choice given firm 1's output is illustrated by the reaction function $R_2(q_1)$. In equilibrium firm 1's optimal quantity choice, q_1*, is equal to firm 2's optimal quantity choice, q_2*, when $R_1(q_2) = R_2(q_1)$. This equilibrium is considered Nash.

Figure A3: Firm Specific Residual Demand Curve in a Duopoly under Bertrand Price Competition.



The illustration reveals firm 2's residual demand curve assuming that firm 1 sets its price at P_1. For any price above P_1 firm 1 captures the entire market and firm 2 sells nothing. If firm 2 charges a price equal to P_1 we assume that they split the market. In the above figure at the price $P_2=P_1$ the horizontal dashed line illustrates the quantity provided by firm 1 while the solid horizontal line illustrates the quantity sold by firm 2. For any price below P_1 firm 2 captures the entire market.

Figure A4: Market Structure and Conduct as Proposed by Choi (1991)



In the above illustration let M_i represent the *i*th manufacturer, R the retailer, and w_i and p_i wholesale and retailer prices. Incoming arrows indicate that a channel member conditions its price on the other's price decision at the tail of the arrow. In the vertical Nash game neither manufacturer knows the others wholesale price, however, both observe all retail prices. Each manufacturer conditions its price on its competitor's retail price and the retailer's margin on its own product. The retailer conditions its price on both wholesale prices. Such a structure may exist when there are few small to medium sized manufacturers and retailers. In the Manufacturer Stackelberg game each manufacturer is large and leads the market with respect to retailers. Each manufacturer conditions its wholesale price on the reaction function of retailers and other manufacturer wholesale prices. Each retailer selects its optimum retail price after observing wholesale prices. In the Retailer Stackelberg game each manufacturer conditions its price based on its competitors retail price and retailer's margin on its own product. Retailers are considered to be relatively large and condition their price on the reaction functions of manufacturers.

Appendix 3

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

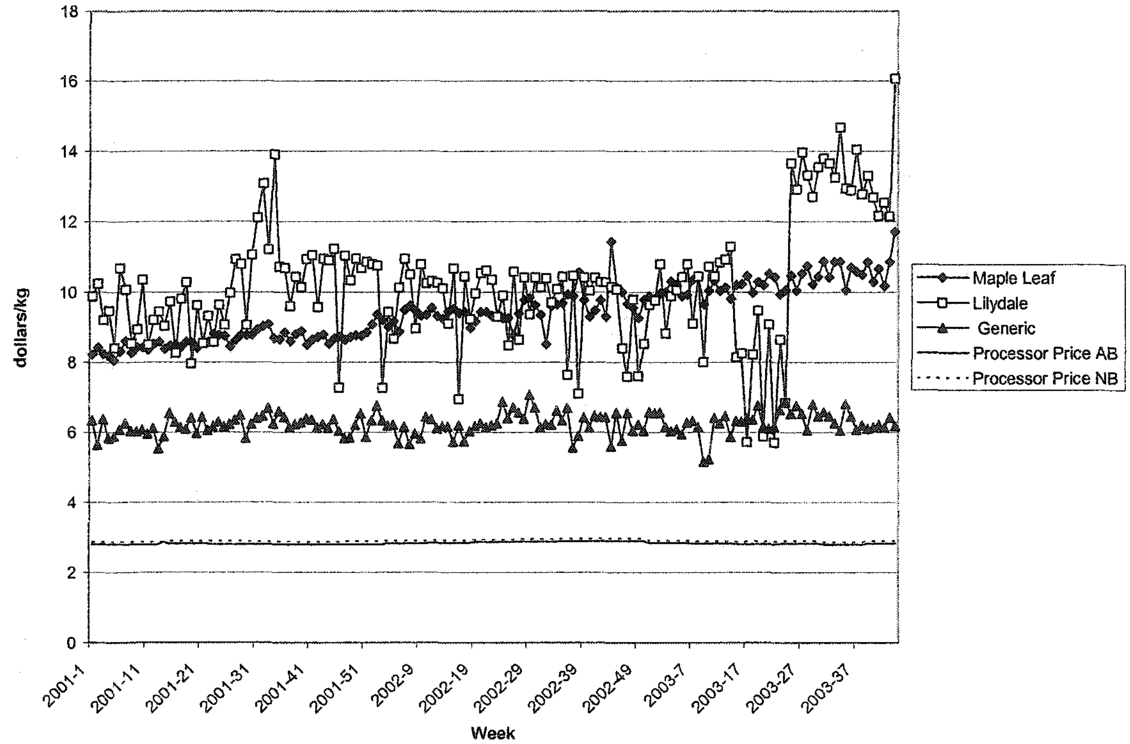


Figure A6: Weekly Canadian Fresh Chicken Retail Sales by Volume (2001:1-2003:44)

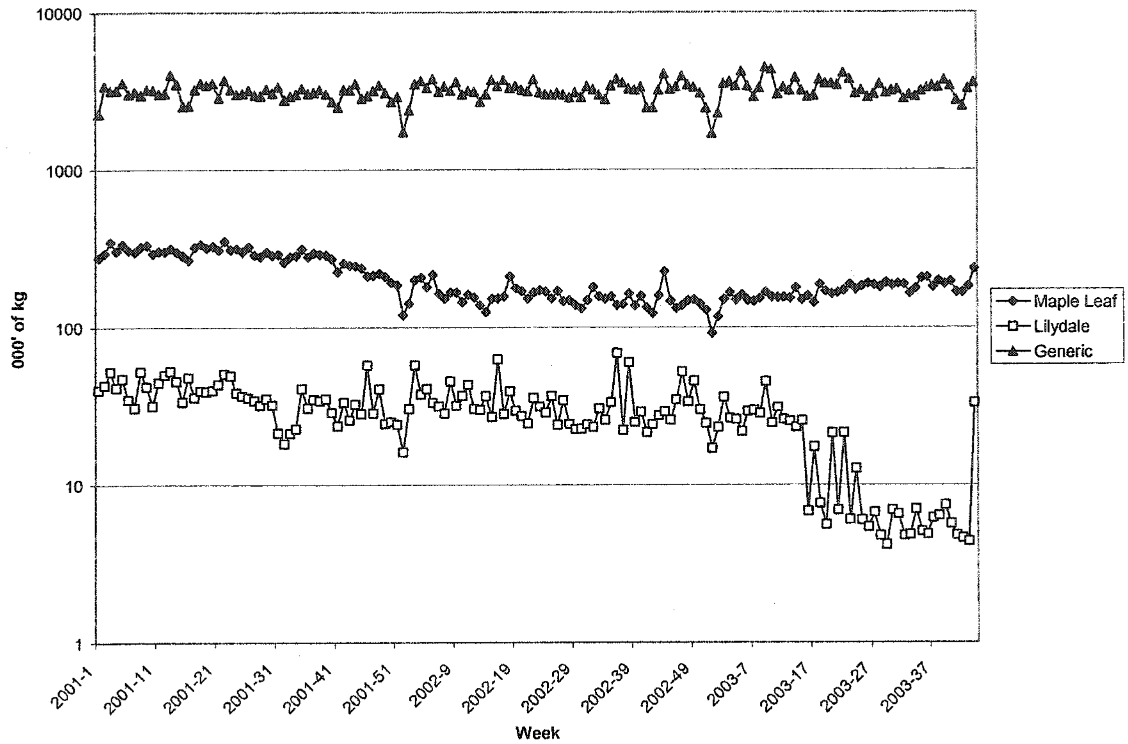


Figure A7: Weekly Canadian Fresh Chicken Retail Sales by Value (2001:1-2003:44)

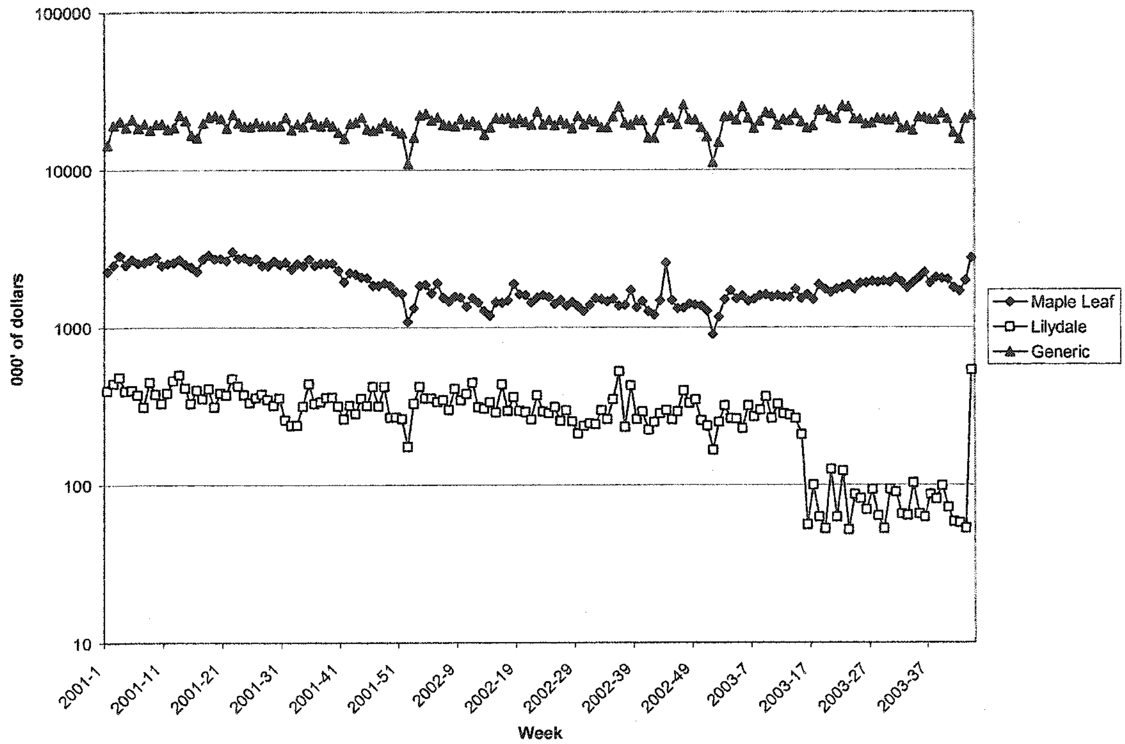


Figure A8: Quarterly Australian Average Egg Prices (1998:2-2002:4)

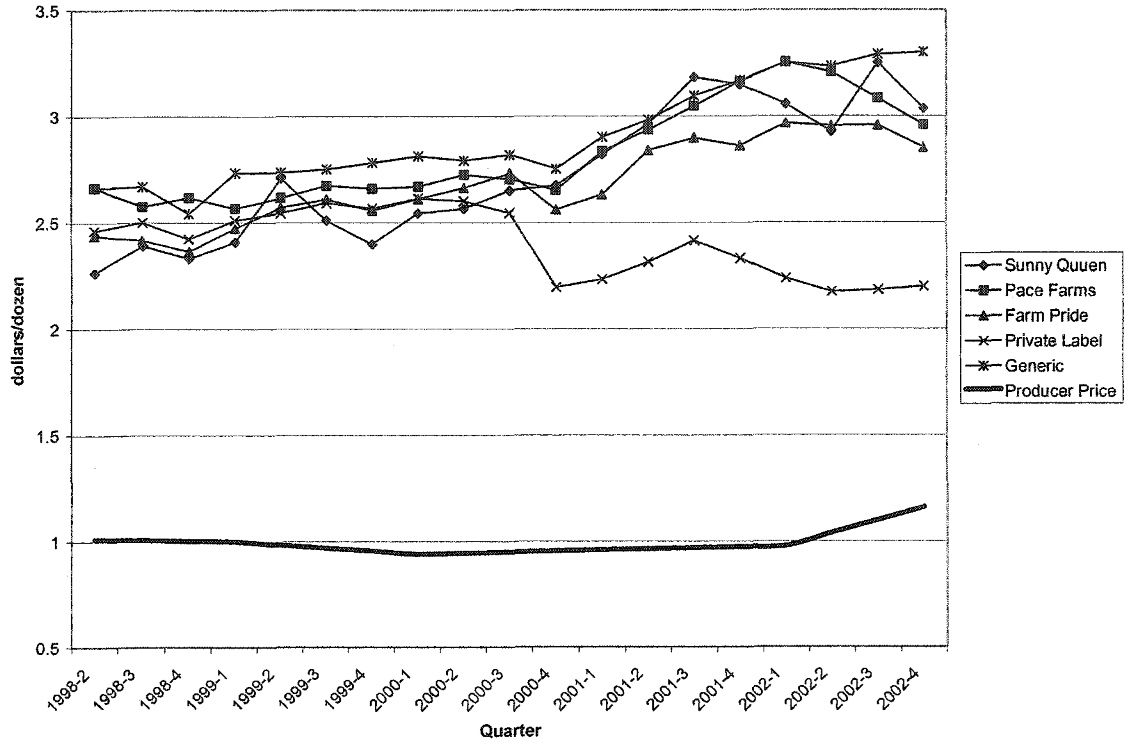


Figure A9: Quarterly Australian Egg Retail Sales by Volume (1998:2-2002:4)

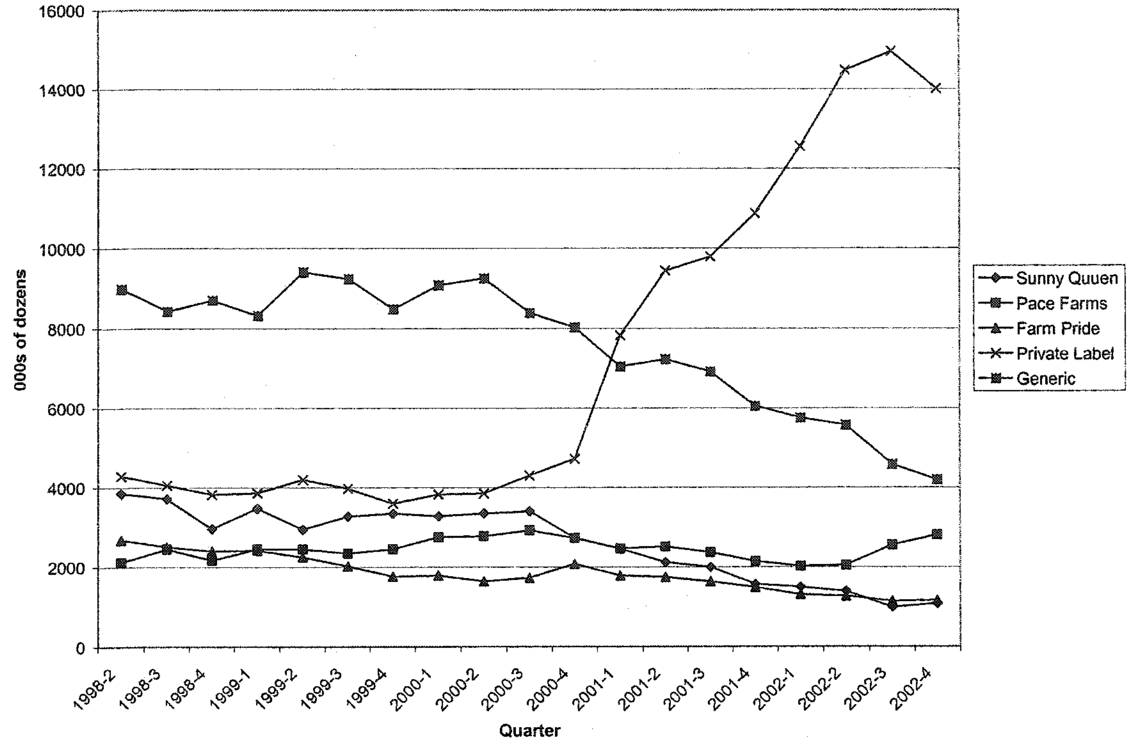


Figure A10: Quarterly Australian Egg Retail Sales by Value (1998:2-2002:4)

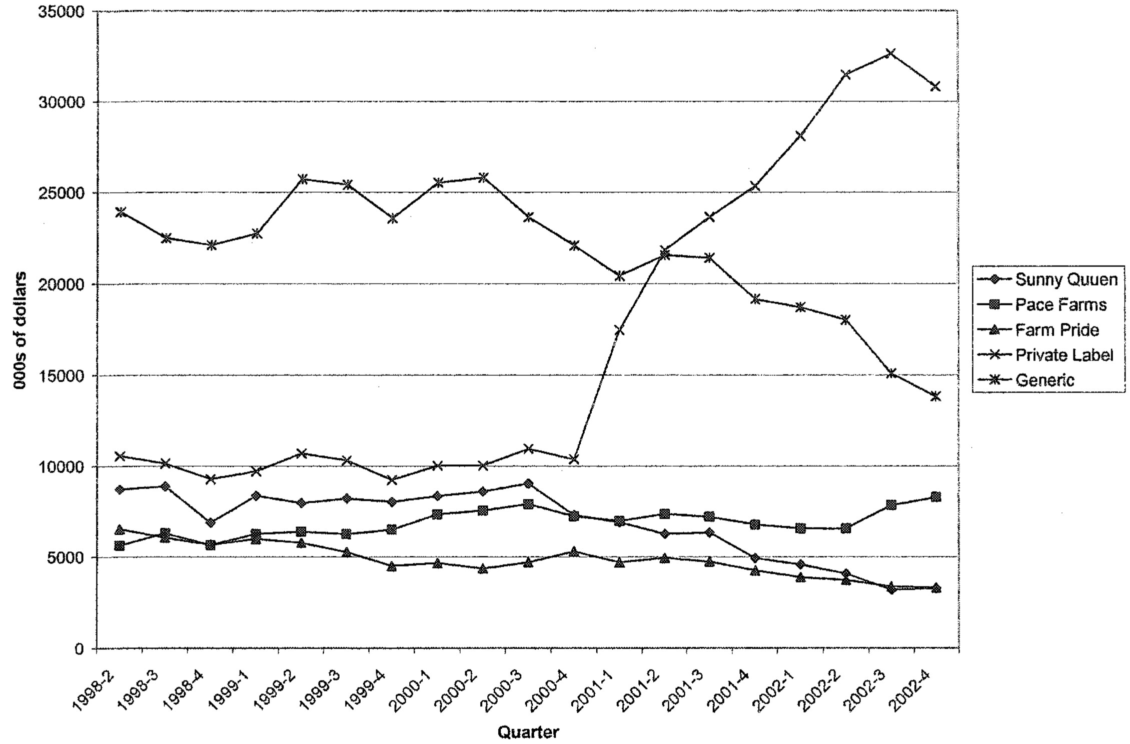
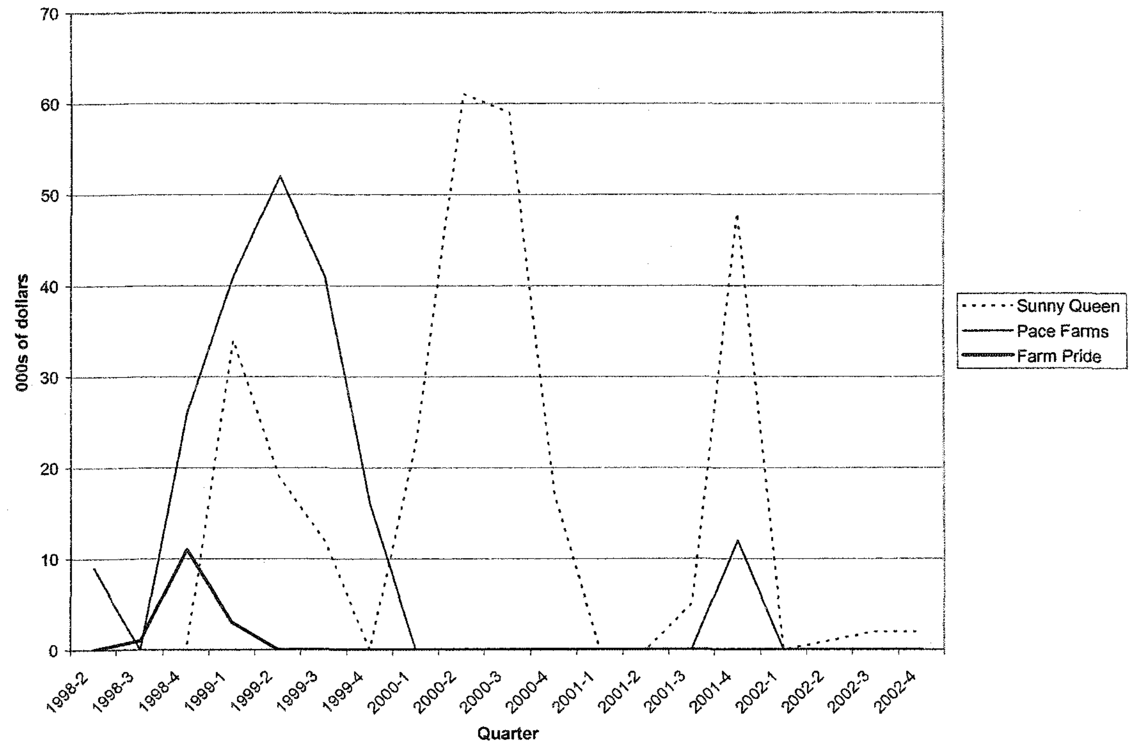


Figure A11: Quarterly Australian Egg Advertising by Brand (1998:2-2002:4)



Appendix 4

Table A2: Canadian Fresh Chicken Market: Bertrand Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	49536	10544.5	4.698	[.000]
$\alpha 2$	66802.1	47662.7	1.402	[.161]
$\alpha 3$	3.86E+06	72405.3	53.366	[.000]
$\gamma 11$	-456528	21596.6	-21.139	[.000]
$\gamma 12 = \gamma 21$	609035	113956	5.344	[.000]
$\gamma 13 = \gamma 31$	-433770	188416	-2.302	[.021]
$\gamma 22$	-2.10E+06	99977.1	-21.007	[.000]
$\gamma 23 = \gamma 32$	1.47E+06	733987	2.008	[.045]
$\gamma 33$	-7.22E+07	1.41E+06	-51.271	[.000]
$\mu 11$	-231.222	20.0046	-11.559	[.000]
$\mu 21$	-815.663	63.3438	-12.877	[.000]
$\mu 31$	-543.364	143.386	-3.790	[.000]
$\mu 12$	0.010854	1.13E-03	9.605	[.000]
$\mu 22$	4.92E-04	2.71E-04	1.817	[.069]
$\mu 32$	0.139128	2.11E-03	65.892	[.000]

Table A3: Canadian Fresh Chicken Market: Stackelberg-Lilydale Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	29984.7	9574.72	3.132	[.002]
$\alpha 2$	51804.2	45396.5	1.141	[.254]
$\alpha 3$	3.87E+06	71320.7	54.258	[.000]
$\gamma 11$	-237445	22420.6	-10.591	[.000]
$\gamma 12 = \gamma 21$	628811	108312	5.806	[.000]
$\gamma 13 = \gamma 31$	-789016	162752	-4.848	[.000]
$\gamma 22$	-2.24E+06	111001	-20.187	[.000]
$\gamma 23 = \gamma 32$	2.72E+06	722979	3.765	[.000]
$\gamma 33$	-7.41E+07	1.41E+06	-52.593	[.000]
$\mu 11$	-247.033	18.4355	-13.400	[.000]
$\mu 21$	-818.193	60.7337	-13.472	[.000]
$\mu 31$	-622.143	143.549	-4.334	[.000]
$\mu 12$	9.02E-03	1.07E-03	8.455	[.000]
$\mu 22$	1.36E-03	2.30E-04	5.915	[.000]
$\mu 32$	0.140438	2.08E-03	67.498	[.000]

Table A4: Canadian Fresh Chicken Market: Stackelberg-Maple Leaf Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	46202.4	10570.1	4.371	[.000]
$\alpha 2$	-4683.27	47644.4	-0.098	[.922]
$\alpha 3$	3.92E+06	72122.1	54.412	[.000]
$\gamma 11$	-451514	21172.2	-21.326	[.000]
$\gamma 12 = \gamma 21$	849246	117419	7.233	[.000]
$\gamma 13 = \gamma 31$	-716375	190216	-3.766	[.000]
$\gamma 22$	-1.26E+06	140696	-8.983	[.000]
$\gamma 23 = \gamma 32$	890977	731498	1.218	[.223]
$\gamma 33$	-7.15E+07	1.37E+06	-52.125	[.000]
$\mu 11$	-250.687	20.3039	-12.347	[.000]
$\mu 21$	-967.611	63.9287	-15.136	[.000]
$\mu 31$	-404.123	142.623	-2.834	[.005]
$\mu 12$	0.012024	1.16E-03	10.357	[.000]
$\mu 22$	5.01E-04	2.71E-04	1.848	[.065]
$\mu 32$	0.137325	2.13E-03	64.419	[.000]

Table A5: Canadian Fresh Chicken Market: Stackelberg-Generic Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	46060.6	10538.3	4.371	[.000]
$\alpha 2$	113848	48489.5	2.348	[.019]
$\alpha 3$	3.83E+06	72734.6	52.695	[.000]
$\gamma 11$	-457061	21650.3	-21.111	[.000]
$\gamma 12 = \gamma 21$	582779	113599	5.130	[.000]
$\gamma 13 = \gamma 31$	-336508	187690	-1.793	[.073]
$\gamma 22$	-2.10E+06	95890	-21.849	[.000]
$\gamma 23 = \gamma 32$	721500	744875	0.969	[.333]
$\gamma 33$	-7.10E+07	1.44E+06	-49.300	[.000]
$\mu 11$	-228.251	19.9797	-11.424	[.000]
$\mu 21$	-818.925	63.1428	-12.969	[.000]
$\mu 31$	-462.377	144.576	-3.198	[.001]
$\mu 12$	0.010589	1.13E-03	9.401	[.000]
$\mu 22$	5.03E-04	2.71E-04	1.861	[.063]
$\mu 32$	0.139622	2.11E-03	66.222	[.000]

Table A6: Canadian Fresh Chicken Market: Bertrand Model Parameter Estimates when Lilydale Operates as a Producer Cooperative

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	40219.6	11020.5	3.650	[.000]
$\alpha 2$	139612	44465.5	3.140	[.002]
$\alpha 3$	3.72E+06	64823.4	57.458	[.000]
$\gamma 11$	-435582	48622	-8.959	[.000]
$\gamma 12 = \gamma 21$	812302	119416	6.802	[.000]
$\gamma 13 = \gamma 31$	-692881	194233	-3.567	[.000]
$\gamma 22$	-1.79E+06	64022.1	-28.004	[.000]
$\gamma 23 = \gamma 32$	-543176	619031	-0.877	[.380]
$\gamma 33$	-6.66E+07	934571	-71.312	[.000]
$\mu 11$	-302.149	20.7823	-14.539	[.000]
$\mu 21$	-755.385	63.0389	-11.983	[.000]
$\mu 31$	-373.915	133.113	-2.809	[.005]
$\mu 12$	0.010212	1.13E-03	9.042	[.000]
$\mu 22$	9.26E-04	2.90E-04	3.189	[.001]
$\mu 32$	0.139941	2.07E-03	67.710	[.000]

Table A7: Canadian Fresh Chicken Market: Stackelberg-Maple Leaf Model Parameter Estimates When Lilydale Operates as a Producer Cooperative but is Treated as IOF by Other Market Participants

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	32479.5	10997.9	2.953	[.003]
$\alpha 2$	93212.6	43775.6	2.129	[.033]
$\alpha 3$	3.78E+06	64915.4	58.223	[.000]
$\gamma 11$	-370092	47559.4	-7.782	[.000]
$\gamma 12 = \gamma 21$	1.24E+06	123509	10.013	[.000]
$\gamma 13 = \gamma 31$	-1.19E+06	196063	-6.058	[.000]
$\gamma 22$	-1.81E+06	237235	-7.630	[.000]
$\gamma 23 = \gamma 32$	-667884	625288	-1.068	[.285]
$\gamma 33$	-6.63E+07	922554	-71.838	[.000]
$\mu 11$	-355.355	20.9196	-16.987	[.000]
$\mu 21$	-802.936	64.1377	-12.519	[.000]
$\mu 31$	-288.909	134.123	-2.154	[.031]
$\mu 12$	0.011147	1.15E-03	9.675	[.000]
$\mu 22$	8.56E-04	2.91E-04	2.945	[.003]
$\mu 32$	0.13871	2.09E-03	66.275	[.000]

Table A8: Canadian Fresh Chicken Market: Stackelberg-Generic Model Parameter Estimates When Lilydale Operates as a Producer Cooperative but is Treated as IOF by Other Market Participants

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	39362.7	11017.9	3.573	[.000]
$\alpha 2$	154981	43377.1	3.573	[.000]
$\alpha 3$	3.69E+06	65983.3	55.898	[.000]
$\gamma 11$	-439138	48654.7	-9.026	[.000]
$\gamma 12 = \gamma 21$	797338	118407	6.734	[.000]
$\gamma 13 = \gamma 31$	-649598	191913	-3.385	[.001]
$\gamma 22$	-1.81E+06	65137.1	-27.722	[.000]
$\gamma 23 = \gamma 32$	-777711	584507	-1.331	[.183]
$\gamma 33$	-6.58E+07	868600	-75.736	[.000]
$\mu 11$	-299.847	20.687	-14.494	[.000]
$\mu 21$	-759.283	62.8656	-12.078	[.000]
$\mu 31$	-336.612	129.815	-2.593	[.010]
$\mu 12$	0.010174	1.13E-03	9.020	[.000]
$\mu 22$	9.19E-04	2.90E-04	3.165	[.002]
$\mu 32$	0.140116	2.06E-03	67.862	[.000]

Table A9: Canadian Fresh Chicken Market: Stackelberg-Maple Leaf Model Parameter Estimates when Lilydale Operates as a Producer Cooperative and is Treated as Producer Cooperative by other Market Participants

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	40081.6	11020.6	3.637	[.000]
$\alpha 2$	141376	44562.5	3.173	[.002]
$\alpha 3$	3.73E+06	64807.9	57.487	[.000]
$\gamma 11$	-435637	48622.3	-8.960	[.000]
$\gamma 12 = \gamma 21$	812335	119397	6.804	[.000]
$\gamma 13 = \gamma 31$	-690392	194169	-3.556	[.000]
$\gamma 22$	-1.78E+06	62819.2	-28.388	[.000]
$\gamma 23 = \gamma 32$	-587551	617123	-0.952	[.341]
$\gamma 33$	-6.66E+07	933115	-71.384	[.000]
$\mu 11$	-302.148	20.7801	-14.540	[.000]
$\mu 21$	-756.033	62.9857	-12.003	[.000]
$\mu 31$	-370.324	133.119	-2.782	[.005]
$\mu 12$	0.010205	1.13E-03	9.041	[.000]
$\mu 22$	9.26E-04	2.90E-04	3.191	[.001]
$\mu 32$	0.139947	2.07E-03	67.735	[.000]

Table A10: Canadian Fresh Chicken Market: Stackelberg-Generic Model Parameter Estimates when Lilydale Operates as a Producer Cooperative and Treated as producer Cooperative by Other Market Participants

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	40638.2	11020.5	3.688	[.000]
$\alpha 2$	137296	43168.6	3.180	[.001]
$\alpha 3$	3.72E+06	65271.9	56.924	[.000]
$\gamma 11$	-435589	48625.8	-8.958	[.000]
$\gamma 12= \gamma 21$	812802	119438	6.805	[.000]
$\gamma 13= \gamma 31$	-699964	194457	-3.600	[.000]
$\gamma 22$	-1.80E+06	64552.3	-27.855	[.000]
$\gamma 23= \gamma 32$	-499029	588732	-0.848	[.397]
$\gamma 33$	-6.65E+07	892024	-74.580	[.000]
$\mu 11$	-302.266	20.7882	-14.540	[.000]
$\mu 21$	-755.598	62.9955	-11.995	[.000]
$\mu 31$	-374.701	130.979	-2.861	[.004]
$\mu 12$	0.010226	1.13E-03	9.058	[.000]
$\mu 22$	9.21E-04	2.90E-04	3.173	[.002]
$\mu 32$	0.139951	2.07E-03	67.750	[.000]

Figure A12: Marshallian and Hicksian Demand Elasticities.

The use of Marshallian (uncompensated) and Hicksian (compensated) demand elasticities is important when assessing the change in quantity demanded as a result of a price change. When a good's price changes, a consumer notices two effects, a substitution effect and an income effect (Katz and Rosen, 1998). The substitution effect is the effect of a price change on quantity demanded exclusively due to the fact that, that good's relative price has changed. The income effect, is the effect of a price change on the quantity demanded exclusively due to fact that the consumers' real income has changed. The Slutsky equation is often used to illustrate the combined influence of substitution and income effects. A typical illustration of the Slutsky equation is

$\frac{\partial q_i^M}{\partial p_j} = \frac{\partial q_i^H}{\partial p_j} - q_i \frac{\partial q_i^M}{\partial M}$ where i and j take the values 0…n goods.

In this expression q_i^M represents Marshallian demand, q_i^H represents Hicksian demand, M represent income and q_i represents quantity consumed. The first term on the left-hand side of the Slutsky relation, $\frac{\partial q_i^H}{\partial p_j}$, illustrates the portion of gross demand change that results from substitution. This can also be called the net substitution effect. The second term $-q_i \frac{\partial q_i^M}{\partial M}$ represents the portion of gross demand change that results from alternations in real income. A good is considered a gross substitute if $\frac{\partial q_i^M}{\partial p_j} = \frac{\partial q_i^H}{\partial p_j} - q_i \frac{\partial q_i^M}{\partial M} < 0$ and a gross complement if $\frac{\partial q_i^M}{\partial p_j} = \frac{\partial q_i^H}{\partial p_j} - q_i \frac{\partial q_i^M}{\partial M} > 0$. Conversely, a good is considered a net substitute if $\frac{\partial q_i^H}{\partial p_j} = \frac{\partial q_i^M}{\partial p_j} + q_i \frac{\partial q_i^M}{\partial M} < 0$ and a net compliment, if $\frac{\partial q_i^H}{\partial p_j} = \frac{\partial q_i^M}{\partial p_j} + q_i \frac{\partial q_i^M}{\partial M} > 0$. Gross substitutes or compliments arise when income is held constant and utility is allowed to change with changes in prices. Net substitutes or compliments arise when utility is held constant, and income is changed with changes in prices.

Table A11: Australian Egg Market: Bertrand Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	4.04E+06	1.26E+06	3.20107	[.001]
$\alpha 2$	4.93E+06	709210	6.94793	[.000]
$\alpha 3$	5.54E+06	572650	9.67447	[.000]
$\alpha 4$	-1.46E+07	3.78E+06	-3.85144	[.000]
$\alpha 5$	1.59E+07	2.31E+06	6.89625	[.000]
$\gamma 11$	-1.71E+08	9.26E+06	-18.4452	[.000]
$\gamma 12 = \gamma 21$	-4.88E+06	2.21E+07	-0.2204	[.826]
$\gamma 13 = \gamma 31$	6.96E+07	1.84E+07	3.77265	[.000]
$\gamma 14 = \gamma 41$	2.38E+07	4.78E+07	0.497545	[.619]
$\gamma 15 = \gamma 51$	8.24E+07	5.70E+07	1.44719	[.148]
$\gamma 22$	-2.65E+08	2.05E+07	-12.9481	[.000]
$\gamma 23 = \gamma 32$	-7.41E+07	1.68E+07	-4.40049	[.000]
$\gamma 24 = \gamma 42$	1.01E+08	3.31E+07	3.06056	[.002]
$\gamma 25 = \gamma 52$	1.20E+08	4.63E+07	2.58079	[.010]
$\gamma 33$	-1.16E+08	6.76E+06	-17.206	[.000]
$\gamma 34 = \gamma 43$	-4.07E+07	2.49E+07	-1.63293	[.102]
$\gamma 35 = \gamma 53$	-6.08E+07	3.74E+07	-1.62605	[.104]
$\gamma 44$	-5.60E+08	2.82E+07	-19.8408	[.000]
$\gamma 45 = \gamma 54$	5.07E+08	9.53E+07	5.31339	[.000]
$\gamma 55$	-1.00E+09	8.77E+07	-11.4513	[.000]
$\lambda 11$	-7575.35	7699.52	-0.98387	[.325]
$\lambda 12$	31096	8654.63	3.59299	[.000]
$\lambda 13$	35705.6	13920.4	2.56499	[.010]
$\lambda 21$	-2196.92	3700.63	-0.59366	[.553]
$\lambda 22$	17339.8	4355.41	1.48792	[.136]
$\lambda 23$	326.835	7029.74	0.046493	[.963]
$\lambda 31$	-1602.93	3163.56	-0.50669	[.612]
$\lambda 32$	-4758.21	3673.32	-1.29534	[.195]
$\lambda 33$	-7603.4	5958.98	-1.27596	[.202]
$\lambda 41$	29284.7	26962.1	1.08614	[.277]
$\lambda 42$	-91845.8	30895.8	-2.97276	[.003]
$\lambda 43$	-196542	46544.1	-4.22271	[.000]
$\lambda 51$	-16889.4	13771	-1.22645	[.220]
$\lambda 52$	18520.9	15191.9	1.21913	[.223]
$\lambda 53$	99890.3	24958.9	4.00219	[.000]
$\mu 11$	-169841	28636.3	-5.93096	[.000]
$\mu 21$	41691.8	18532.6	2.24965	[.024]
$\mu 31$	-86888.4	14398.1	-6.0347	[.000]
$\mu 41$	508918	56605.3	8.99064	[.000]
$\mu 51$	-191370	53883.3	-3.55156	[.000]
$\mu 12$	-8.44E-03	0.018495	-0.45643	[.648]
$\mu 22$	-2.14E-03	0.011267	-0.19035	[.849]
$\mu 32$	0.029926	9.19E-03	3.25613	[.001]
$\mu 42$	0.280489	0.062933	4.45696	[.000]
$\mu 52$	0.059628	0.034036	1.75191	[.080]

Table A12: Australian Egg Market: Stackelberg-Sunny Queen Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	3.93E+06	1.26E+06	3.10703	[.002]
$\alpha 2$	4.94E+06	710706	6.95373	[.000]
$\alpha 3$	5.51E+06	574039	9.60202	[.000]
$\alpha 4$	-1.43E+07	3.79E+06	-3.77682	[.000]
$\alpha 5$	1.59E+07	2.31E+06	6.88858	[.000]
$\gamma 11$	-1.80E+08	1.34E+07	-13.4946	[.000]
$\gamma 12 = \gamma 21$	-4.39E+06	2.05E+07	-0.21422	[.830]
$\gamma 13 = \gamma 31$	7.15E+07	1.71E+07	4.18565	[.000]
$\gamma 14 = \gamma 41$	2.28E+07	4.72E+07	0.482073	[.630]
$\gamma 15 = \gamma 51$	9.37E+07	5.64E+07	1.66155	[.097]
$\gamma 22$	-2.65E+08	2.04E+07	-13.005	[.000]
$\gamma 23 = \gamma 32$	-7.43E+07	1.69E+07	-4.40518	[.000]
$\gamma 24 = \gamma 42$	1.02E+08	3.34E+07	3.06363	[.002]
$\gamma 25 = \gamma 52$	1.16E+08	4.65E+07	2.49936	[.012]
$\gamma 33$	-1.15E+08	6.80E+06	-16.9872	[.000]
$\gamma 34 = \gamma 43$	-4.08E+07	2.51E+07	-1.62805	[.104]
$\gamma 35 = \gamma 53$	-5.95E+07	3.75E+07	-1.5847	[.113]
$\gamma 44$	-5.69E+08	3.11E+07	-18.3242	[.000]
$\gamma 45 = \gamma 54$	5.06E+08	9.51E+07	5.3149	[.000]
$\gamma 55$	-1.00E+09	8.70E+07	-11.5518	[.000]
$\lambda 11$	-7599.16	7691	-0.98806	[.323]
$\lambda 12$	31580.5	8617.05	3.66488	[.000]
$\lambda 13$	36144.1	13929.3	2.59482	[.009]
$\lambda 21$	-2207.38	3727.39	-0.59221	[.554]
$\lambda 22$	17216.2	4364.5	1.48109	[.136]
$\lambda 23$	543.695	7079.02	0.076804	[.939]
$\lambda 31$	-1543.66	3167.93	-0.48728	[.626]
$\lambda 32$	-4577.26	3660.74	-1.25036	[.211]
$\lambda 33$	-7788.66	5968.32	-1.305	[.192]
$\lambda 41$	29020.8	26887.9	1.07933	[.280]
$\lambda 42$	-93356.3	30795.9	-3.03146	[.002]
$\lambda 43$	-197733	46411.7	-4.26041	[.000]
$\lambda 51$	-16749.1	13771.4	-1.21622	[.224]
$\lambda 52$	18697.2	15168.7	1.23262	[.218]
$\lambda 53$	99794	24950.4	3.99969	[.000]
$\mu 11$	-171022	28366	-6.02914	[.000]
$\mu 21$	42053.7	18674.7	2.25191	[.024]
$\mu 31$	-87008.7	14432.2	-6.02878	[.000]
$\mu 41$	508128	56424	9.00552	[.000]
$\mu 51$	-192151	53670.9	-3.58018	[.000]
$\mu 12$	-8.03E-03	0.018047	-0.44479	[.656]
$\mu 22$	-1.49E-03	0.011105	-0.13455	[.893]
$\mu 32$	0.029044	9.07E-03	3.20289	[.001]
$\mu 42$	0.280159	0.062704	4.46798	[.000]
$\mu 52$	0.057391	0.033875	1.69417	[.090]

Table A13: Australian Egg Market: Stackelberg-Pace Farms Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	3.95E+06	1.26E+06	3.12207	[.002]
$\alpha 2$	4.82E+06	706989	6.81945	[.000]
$\alpha 3$	5.53E+06	561759	9.8524	[.000]
$\alpha 4$	-1.36E+07	3.77E+06	-3.59153	[.000]
$\alpha 5$	1.54E+07	2.29E+06	6.74027	[.000]
$\gamma 11$	-1.79E+08	1.09E+07	-16.4376	[.000]
$\gamma 12= \gamma 21$	-4.32E+06	2.23E+07	-0.19428	[.846]
$\gamma 13= \gamma 31$	6.81E+07	1.85E+07	3.68926	[.000]
$\gamma 14= \gamma 41$	3.34E+07	4.83E+07	0.692222	[.489]
$\gamma 15= \gamma 51$	8.44E+07	5.71E+07	1.47854	[.139]
$\gamma 22$	-2.70E+08	1.58E+07	-17.0942	[.000]
$\gamma 23= \gamma 32$	-7.84E+07	1.18E+07	-6.64229	[.000]
$\gamma 24= \gamma 42$	1.20E+08	3.25E+07	3.70113	[.000]
$\gamma 25= \gamma 52$	1.07E+08	4.54E+07	2.35383	[.019]
$\gamma 33$	-1.22E+08	7.99E+06	-15.3151	[.000]
$\gamma 34= \gamma 43$	-5.53E+07	2.49E+07	-2.2204	[.026]
$\gamma 35= \gamma 53$	-3.15E+07	3.62E+07	-0.86994	[.384]
$\gamma 44$	-5.68E+08	2.96E+07	-19.1996	[.000]
$\gamma 45= \gamma 54$	4.30E+08	9.55E+07	4.50764	[.000]
$\gamma 55$	-8.75E+08	8.48E+07	-10.3216	[.000]
$\lambda 11$	-7478.65	7713.85	-0.96951	[.332]
$\lambda 12$	31337.6	8668.16	3.61525	[.000]
$\lambda 13$	35274.1	13955	2.52771	[.011]
$\lambda 21$	-927.966	3733.38	-0.24856	[.804]
$\lambda 22$	16395.3	4343.79	1.47868	[.138]
$\lambda 23$	-1871.95	7110.45	-0.26327	[.792]
$\lambda 31$	-2189.8	3126.79	-0.70033	[.484]
$\lambda 32$	-4077.51	3616.8	-1.12738	[.260]
$\lambda 33$	-5374.07	5954.41	-0.90254	[.367]
$\lambda 41$	28189.7	26892.4	1.04824	[.295]
$\lambda 42$	-94334	30813.7	-3.06143	[.002]
$\lambda 43$	-196729	46422.5	-4.23779	[.000]
$\lambda 51$	-19488.3	13694.1	-1.42312	[.155]
$\lambda 52$	23099.5	15080.5	1.53175	[.126]
$\lambda 53$	108139	24840.8	4.35326	[.000]
$\mu 11$	-165984	28838.6	-5.75563	[.000]
$\mu 21$	51111.8	18580.7	2.7508	[.006]
$\mu 31$	-95018.7	14411.6	-6.59322	[.000]
$\mu 41$	509497	56466.5	9.02299	[.000]
$\mu 51$	-231350	53749.9	-4.3042	[.000]
$\mu 12$	-7.91E-03	0.018563	-0.42601	[.670]
$\mu 22$	6.63E-04	0.011293	0.058677	[.953]
$\mu 32$	0.028728	9.05E-03	3.17421	[.002]
$\mu 42$	0.288937	0.062774	4.60279	[.000]
$\mu 52$	0.043131	0.033756	1.27773	[.201]

Table A14: Australian Egg Market: Stackelberg-Farm Pride Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	4.08E+06	1.25E+06	3.25527	[.001]
$\alpha 2$	4.88E+06	705376	6.92019	[.000]
$\alpha 3$	5.58E+06	570932	9.76518	[.000]
$\alpha 4$	-1.45E+07	3.78E+06	-3.84458	[.000]
$\alpha 5$	1.59E+07	2.31E+06	6.9033	[.000]
$\gamma 11$	-1.70E+08	9.16E+06	-18.6149	[.000]
$\gamma 12= \gamma 21$	-8.39E+06	2.18E+07	-0.38443	[.701]
$\gamma 13= \gamma 31$	7.22E+07	1.79E+07	4.03669	[.000]
$\gamma 14= \gamma 41$	2.11E+07	4.73E+07	0.446876	[.655]
$\gamma 15= \gamma 51$	8.38E+07	5.63E+07	1.48727	[.137]
$\gamma 22$	-2.64E+08	1.97E+07	-13.3853	[.000]
$\gamma 23= \gamma 32$	-7.39E+07	1.57E+07	-4.72312	[.000]
$\gamma 24= \gamma 42$	1.03E+08	3.24E+07	3.18402	[.001]
$\gamma 25= \gamma 52$	1.20E+08	4.55E+07	2.64651	[.008]
$\gamma 33$	-1.22E+08	9.90E+06	-12.3487	[.000]
$\gamma 34= \gamma 43$	-4.04E+07	2.45E+07	-1.64511	[.100]
$\gamma 35= \gamma 53$	-6.01E+07	3.69E+07	-1.62828	[.103]
$\gamma 44$	-5.62E+08	2.85E+07	-19.6939	[.000]
$\gamma 45= \gamma 54$	5.02E+08	9.43E+07	5.32	[.000]
$\gamma 55$	-9.99E+08	8.48E+07	-11.7823	[.000]
$\lambda 11$	-7728.19	7646.78	-1.01065	[.312]
$\lambda 12$	31143.6	8599.9	3.62139	[.000]
$\lambda 13$	35973.5	13827.2	2.60165	[.009]
$\lambda 21$	-2104.09	3682.09	-0.57144	[.568]
$\lambda 22$	17282.9	4331.07	1.49168	[.135]
$\lambda 23$	345.702	6991.03	0.049449	[.961]
$\lambda 31$	-1662.3	3157.59	-0.52645	[.599]
$\lambda 32$	-4725.4	3662.98	-1.29004	[.197]
$\lambda 33$	-7519.42	5959.05	-1.26185	[.207]
$\lambda 41$	29337.9	26978.9	1.08744	[.277]
$\lambda 42$	-92076.4	30914.4	-2.97843	[.003]
$\lambda 43$	-196107	46576.6	-4.21041	[.000]
$\lambda 51$	-17062.1	13753.1	-1.2406	[.215]
$\lambda 52$	18632.7	15152.7	1.22966	[.219]
$\lambda 53$	99967.8	24898.6	4.015	[.000]
$\mu 11$	-171449	28280.5	-6.06242	[.000]
$\mu 21$	42607.3	18187.7	2.34265	[.019]
$\mu 31$	-87119.9	14196.5	-6.13671	[.000]
$\mu 41$	509325	56647.9	8.99106	[.000]
$\mu 51$	-193419	53346.1	-3.62574	[.000]
$\mu 12$	-8.31E-03	0.018357	-0.45244	[.651]
$\mu 22$	-1.70E-03	0.011082	-0.15312	[.878]
$\mu 32$	0.030014	8.91E-03	3.36901	[.001]
$\mu 42$	0.281946	0.062914	4.48147	[.000]
$\mu 52$	0.058315	0.033771	1.72678	[.084]

Table A15: Australian Egg Market: Stackelberg-Private Label Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	4.18E+06	1.22E+06	3.42728	[.001]
$\alpha 2$	4.95E+06	706673	6.99944	[.000]
$\alpha 3$	5.53E+06	574584	9.62865	[.000]
$\alpha 4$	-1.49E+07	3.58E+06	-4.17845	[.000]
$\alpha 5$	1.57E+07	2.29E+06	6.87709	[.000]
$\gamma 11$	-1.79E+08	1.21E+07	-14.7743	[.000]
$\gamma 12= \gamma 21$	-207876	2.23E+07	-9.34E-03	[.993]
$\gamma 13= \gamma 31$	6.74E+07	1.86E+07	3.62121	[.000]
$\gamma 14= \gamma 41$	1.48E+07	4.64E+07	0.318557	[.750]
$\gamma 15= \gamma 51$	8.32E+07	5.75E+07	1.44733	[.148]
$\gamma 22$	-2.64E+08	1.90E+07	-13.94	[.000]
$\gamma 23= \gamma 32$	-7.41E+07	1.62E+07	-4.56592	[.000]
$\gamma 24= \gamma 42$	1.01E+08	3.32E+07	3.04638	[.002]
$\gamma 25= \gamma 52$	1.15E+08	4.54E+07	2.53958	[.011]
$\gamma 33$	-1.19E+08	7.59E+06	-15.7358	[.000]
$\gamma 34= \gamma 43$	-3.87E+07	2.55E+07	-1.52077	[.128]
$\gamma 35= \gamma 53$	-5.95E+07	3.62E+07	-1.64244	[.100]
$\gamma 44$	-5.45E+08	3.27E+07	-16.6966	[.000]
$\gamma 45= \gamma 54$	5.28E+08	1.00E+08	5.27772	[.000]
$\gamma 55$	-1.01E+09	7.85E+07	-12.9115	[.000]
$\lambda 11$	-8259.69	7504.16	-1.10068	[.271]
$\lambda 12$	31697.1	8476.84	3.73926	[.000]
$\lambda 13$	36191.3	13619	2.6574	[.008]
$\lambda 21$	-2393.59	3702.73	-0.64644	[.518]
$\lambda 22$	17457.3	4371.93	1.49298	[.135]
$\lambda 23$	585.617	7058.76	0.082963	[.934]
$\lambda 31$	-1384.25	3187.78	-0.434238	[.664]
$\lambda 32$	-4752.27	3699.86	-1.28444	[.199]
$\lambda 33$	-8246.45	6018.69	-1.37014	[.171]
$\lambda 41$	30574.6	26053.4	1.17354	[.241]
$\lambda 42$	-93696	29970.8	-3.12624	[.002]
$\lambda 43$	-195024	45190.6	-4.3156	[.000]
$\lambda 51$	-15325.7	13889.7	-1.10338	[.270]
$\lambda 52$	18266.2	15201.9	1.20158	[.230]
$\lambda 53$	95229.6	25343.4	3.75757	[.000]
$\mu 11$	-174977	28046.1	-6.23891	[.000]
$\mu 21$	40788.6	18588.5	2.19429	[.028]
$\mu 31$	-85502.3	14630.7	-5.84404	[.000]
$\mu 41$	520173	56608.7	9.18893	[.000]
$\mu 51$	-178779	56117.9	-3.18577	[.001]
$\mu 12$	-5.72E-03	0.01827	-0.313038	[.754]
$\mu 22$	-2.49E-03	0.011316	-0.220067	[.826]
$\mu 32$	0.030607	9.28E-03	3.29975	[.001]
$\mu 42$	0.275161	0.061121	4.50191	[.000]
$\mu 52$	0.059853	0.033917	1.76469	[.078]

Table A16: Australian Egg Market: Stackelberg-Generic Model Parameter Estimates.

Parameter	Estimate	Error	t-statistic	P-value
$\alpha 1$	5.63E+06	983666	5.72524	[.000]
$\alpha 2$	4.22E+06	637509	6.61847	[.000]
$\alpha 3$	6.10E+06	533658	11.4386	[.000]
$\alpha 4$	-1.76E+07	3.48E+06	-5.05692	[.000]
$\alpha 5$	1.65E+07	1.94E+06	8.51304	[.000]
$\gamma 11$	-1.70E+08	9.14E+06	-18.5659	[.000]
$\gamma 12= \gamma 21$	1.75E+07	1.82E+07	0.960494	[.337]
$\gamma 13= \gamma 31$	5.03E+07	1.61E+07	3.13164	[.002]
$\gamma 14= \gamma 41$	-2.86E+07	3.61E+07	-0.79098	[.429]
$\gamma 15= \gamma 51$	1.92E+07	4.99E+07	0.384313	[.701]
$\gamma 22$	-2.56E+08	2.23E+07	-11.4807	[.000]
$\gamma 23= \gamma 32$	-6.78E+07	1.61E+07	-4.21286	[.000]
$\gamma 24= \gamma 42$	7.27E+07	2.24E+07	3.24195	[.001]
$\gamma 25= \gamma 52$	2.06E+08	3.56E+07	5.78445	[.000]
$\gamma 33$	-1.16E+08	6.73E+06	-17.2549	[.000]
$\gamma 34= \gamma 43$	2.63E+06	1.95E+07	0.13477	[.893]
$\gamma 35= \gamma 53$	-1.75E+08	2.97E+07	-5.89046	[.000]
$\gamma 44$	-5.67E+08	3.42E+07	-16.5863	[.000]
$\gamma 45= \gamma 54$	7.72E+08	8.65E+07	8.92619	[.000]
$\gamma 55$	-1.40E+09	1.03E+08	-13.607	[.000]
$\lambda 11$	-14809.9	6135.34	-2.41387	[.016]
$\lambda 12$	35693.3	7063.85	5.05296	[.000]
$\lambda 13$	52793.4	11311.1	4.6674	[.000]
$\lambda 21$	-4148.7	3604.03	-1.15113	[.250]
$\lambda 22$	22367.3	4233.82	1.58214	[.114]
$\lambda 23$	3771.49	6416.47	0.587783	[.557]
$\lambda 31$	871.524	3193.77	0.272882	[.785]
$\lambda 32$	-9796.89	3707.97	-2.64211	[.008]
$\lambda 33$	-13847.1	5706.59	-2.42651	[.015]
$\lambda 41$	37962.8	25419.8	1.49344	[.135]
$\lambda 42$	-98526.7	29303	-3.36235	[.001]
$\lambda 43$	-215018	44403.1	-4.8424	[.000]
$\lambda 51$	-4353.47	14053	-0.30979	[.757]
$\lambda 52$	85.4315	15707.5	5.44E-03	[.996]
$\lambda 53$	65909.9	25671	2.56748	[.010]
$\mu 11$	-203006	22250.7	-9.12359	[.000]
$\mu 21$	22140.2	14001.9	1.58123	[.114]
$\mu 31$	-59693	12195.3	-4.89477	[.000]
$\mu 41$	519409	55660.8	9.3317	[.000]
$\mu 51$	-45919.1	53589.2	-0.85687	[.392]
$\mu 12$	4.26E-03	0.015197	0.280073	[.779]
$\mu 22$	-0.023973	0.01041	-2.30294	[.021]
$\mu 32$	0.050357	8.98E-03	5.60494	[.000]
$\mu 42$	0.25203	0.059321	4.24856	[.000]
$\mu 52$	0.126264	0.034039	3.70944	[.000]

Figure A13: Estimation Goodness of Fit Statistics for Canadian Fresh Chicken: Preferred Model Stackelberg-Generic when Lilydale Operates as a Producer Cooperative but is Treated as an IOF by Other Market Participants.

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Demand Equation Q1 (Lilydale)
Mean of dep. var. = 28832.9                 Std. error of regression = 7967.88
Std. dev. of dep. var. = 13900.8            R-squared = .673593
Sum of squared residuals = .939609E+10      LM het. test = .760727 [.383]
Variance of residuals = .634871E+08         Durbin-Watson = 1.24745

Demand Equation Q2 (Maple Leaf)
Mean of dep. var. = 204788.                 Std. error of regression = 38990.4
Std. dev. of dep. var. = 65403.1            R-squared = .661848
Sum of squared residuals = .224998E+12      LM het. test = 14.9609 [.000]
Variance of residuals = .152025E+10         Durbin-Watson = .386177

Demand Equation Q3 (Generic)
Mean of dep. var. = .318400E+07             Std. error of regression = 68210.9
Std. dev. of dep. var. = 419113.            R-squared = .973674
Sum of squared residuals = .688604E+12      LM het. test = 7.66040 [.006]
Variance of residuals = .465273E+10         Durbin-Watson = .647928

Price Reaction Equation P1 (Lilydale)
Mean of dep. var. = 10.2035                 Std. error of regression = 1.24113
Std. dev. of dep. var. = 1.77146            R-squared = .991742
Sum of squared residuals = 227.980          LM het. test = 117.981 [.000]
Variance of residuals = 1.54041             Durbin-Watson = .048212

Price Reaction Equation P2 (Maple Leaf)
Mean of dep. var. = 9.43851                 Std. error of regression = 3.90164
Std. dev. of dep. var. = .784188            R-squared = .290914
Sum of squared residuals = 2252.98          LM het. test = 116.488 [.000]
Variance of residuals = 15.2228             Durbin-Watson = .067864

Price Reaction Equation P3 (Generic)
Mean of dep. var. = 6.23331                 Std. error of regression = 1.33673
Std. dev. of dep. var. = .311067            R-squared = .448596E-02
Sum of squared residuals = 264.455          LM het. test = 64.8839 [.000]
Variance of residuals = 1.78686             Durbin-Watson = .160485
```

Figure A14: 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 A15: Estimation Goodness of Fit statistics for Australian Eggs Supply Equation Estimation.

```
Mean of dep. var. = .991100               LM het. test = 2.26044 [.133]
Std. dev. of dep. var. = .056972          Durbin-Watson = .845457 [.003,.003]
Sum of squared residuals = .042285        Jarque-Bera test = 1.91688 [.383]
Variance of residuals = .248738E-02       Ramsey's RESET2 = 2.28683 [.150]
Std. error of regression = .049874        Schwarz B.I.C. = -27.4971
R-squared = .331740                       Log likelihood = 28.9423
Adjusted R-squared = .331740
```

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
Quantity	.421651E-04	.499933E-06	84.3415	[.000]

Table A17: Synthetic Model Equation Summary

Equation	Algebraic Representation
Demand	$q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} p_j - \frac{\lambda_g}{adv_g}$
Price Reaction	[1] $p_i = -\frac{1}{2\gamma_{ii}}\left(a_i CPI + \sum_{i \neq j} \gamma_{ij} p_j + X_i CPI\right) + \frac{mc}{2}$ [2] $p_i = mc_i + basis$ $p_k = -\frac{1}{2\gamma_{kk} - \sum_{j \neq k} \frac{\gamma_{ki}^2}{\gamma_{ii}}}\left(a_k CPI + \sum_{j \neq i} \gamma_{ki} p_i + X_k CPI - mc\left(\gamma_{kk} - \sum_{j \neq i} \frac{\gamma_{ki}^2}{\gamma_{ii}}\right)\right)$
Marginal Cost	[3] $mc_i = fp$ [4] $mc_i = fp + basis$
Farm Price	$fp = h + g * q_t + jR_i$
Producer Return on Investment	$\% \; Return = (fp_{Simulation} * Q_{t\,Simulation} - fp_{Base\,Model} * Q_{t\,Base\,Model}) /$ $(Increase\ in\ Expenditure\ over\ Base\ Model)$
Processor Return	$\% \; Return_i = (p_{Simulation} * q_{i\,Simulation} - p_{Base\,Model} * q_{i\,Base\,Model})$

1 Used for IOF Firms
2 Used for Producer Coop
3 Used for Australian Simulation
4 Used for Canadian Simulation

Table A18: Canadian Synthetic Model with Increasing Advertising Investment: Prices and Quantities

		Advertising Investment $750,000				Advertising Investment $1,000,000			
			95% Confidence Interval				95% Confidence Interval		
	Starting Values	Mean	Lower Bound	Upper Bound	Std Dev	Mean	Lower Bound	Upper Bound	Std Dev
Quantity (000's kg)									
q1	931.3	932.8	932.8	932.8	7.8E-02	933.5	933.5	933.6	1.2E-01
q2	8643.9	8652.4	8652.4	8652.5	4.5E-01	8656.6	8656.5	8656.7	6.8E-01
q3	170289.0	170386.1	170385.3	170387.0	5.1E+00	170433.5	170432.2	170434.7	7.7E+00
Prices ($/kg)									
p1	9.80	9.82	9.82	9.82	1.1E-03	9.83	9.83	9.83	1.6E-03
p2	10.28	10.30	10.30	10.30	9.5E-04	10.31	10.31	10.31	1.4E-03
p3	6.25	6.26	6.26	6.26	3.5E-04	6.26	6.26	6.26	5.3E-04
mc_1	2.82	2.83	2.83	2.83	4.6E-04	2.83	2.83	2.83	6.9E-04
mc_2	2.90	2.90	2.90	2.90	1.8E-04	2.91	2.90	2.91	2.7E-04
mc_3	2.90	2.90	2.90	2.90	1.8E-04	2.91	2.90	2.91	2.7E-04
fp_1	1.62	1.63	1.63	1.63	4.6E-04	1.63	1.63	1.63	6.9E-04
fp_2	1.70	1.70	1.70	1.70	1.8E-04	1.71	1.70	1.71	2.7E-04
fp3	1.70	1.70	1.70	1.70	1.8E-04	1.71	1.70	1.71	2.7E-04

qi, pi, mci, and fpi represent the quantities and prices specific to firm i, where i takes the values 1-Lilydale, 2-Maple Leaf, and 3-Generic.

Table A19: Canadian Synthetic Model with Increasing Research Investment: Prices and Quantities

		Research Investment $750,000				Research Investment $1,000,000			
			95% Confidence Interval				95% Confidence Interval		
	Starting Values	Mean	Lower Bound	Upper Bound	Std Dev	Mean	Lower Bound	Upper Bound	Std Dev
Quantity (000's kg)									
q1	931.3	931.8	931.8	931.8	2.1E-02	932.4	932.4	932.4	4.1E-02
q2	8643.9	8646.0	8646.0	8646.0	9.2E-02	8648.3	8648.3	8648.3	1.8E-01
q3	170289.0	170432.1	170431.1	170433.1	6.0E+00	170581.6	170579.7	170583.5	1.2E+01
Prices ($/kg)									
p1	9.80	9.79	9.79	9.79	2.9E-04	9.79	9.79	9.79	5.5E-04
p2	10.28	10.27	10.27	10.27	2.5E-04	10.27	10.27	10.27	4.9E-04
p3	6.25	6.25	6.25	6.25	2.0E-04	6.24	6.24	6.24	3.9E-04
mc_1	2.82	2.81	2.81	2.81	4.5E-04	2.80	2.80	2.80	8.8E-04
mc_2	2.90	2.89	2.89	2.89	4.1E-04	2.88	2.88	2.88	7.9E-04
mc_3	2.90	2.89	2.89	2.89	4.1E-04	2.88	2.88	2.88	7.9E-04
fp_1	1.62	1.61	1.61	1.61	4.5E-04	1.60	1.60	1.60	8.8E-04
fp_2	1.70	1.69	1.69	1.69	4.1E-04	1.68	1.68	1.68	7.9E-04
fp_3	1.70	2.89	2.89	2.89	4.1E-04	2.88	2.88	2.88	7.9E-04

qi, pi, mci, and fpi represent the quantities and prices specific to firm i, where i takes the values 1-Lilydale, 2-Maple Leaf, and 3-Generic.

Table A20: Canadian Synthetic Model with Increasing Advertising Investment: Producer Returns

	Base Model	Advertising Investment $7500,000			Advertising Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
Producers Selling to	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Net Return (000's of $)							
Lilydale	1508.2	1519.2	1519.1	1519.3	1524.3	1524.2	1524.4
Maple or Generic	304185.9	304967.5	304960.8	304974.2	305348.8	305338.7	305359.0
Canadian Average	305694.2	306486.7	306479.9	306493.5	306873.1	306862.8	306883.4
Percent Return on Investment							
Lilydale	-	748	741	755	520	515	526
Maple or Generic	-	214	212	217	134	132	136
Canadian Average	-	217	214	220	136	134	138

Table A21: Canadian Synthetic Model with Increasing Research Investment: Producer Returns

Producers Selling to	Base Model Mean	Research Investment $7500,000 Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Research Investment $1,000,000 Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Net Return (000's of $)							
Lilydale	1508.2	1499.6	1499.5	1499.6	1489.9	1489.8	1490.1
Maple or Generic	304185.9	302696.6	302683.0	302710.2	301136.3	301109.9	301162.7
Canadian Average	305694.2	304196.2	304182.5	304209.9	302626.2	302599.7	302652.8
Percent Return on Investment							
Lilydale	-	-769	-775	-763	-808	-813	-802
Maple or Generic	-	-699	-704	-693	-713	-718	-708
Canadian Average	-	-699	-705	-694	-714	-719	-708

Table A22: Canadian Synthetic Model with Increasing Advertising Investment: Processor Returns

	Base Model	Advertising Investment $750,000			Advertising Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
Processor	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Net Return (000's of $)							
Lilydale	9123.8	9160.8	9160.5	9161.1	9177.3	9176.8	9177.7
Maple Leaf	88859.3	89102.9	89100.8	89105.0	89222.0	89218.8	89225.2
Generic	1064306.3	1066049.3	1066034.3	1066064.3	1066900.2	1066877.5	1066922.8
Percent Increase Over Base							
Lilydale	-	0.406	0.403	0.409	0.586	0.581	0.591
Maple Leaf	-	0.274	0.272	0.276	0.408	0.405	0.412
Generic	-	0.164	0.162	0.165	0.244	0.242	0.246

Table A23: Canadian Synthetic Model with Increasing Research Investment: Processor Returns

	Base Model	Research Investment $750,000			Research Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
Processor	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Net Return (000's of $)							
Lilydale	9123.8	9125.7	9125.7	9125.8	9124.2	9124.1	9124.4
Maple Leaf	88859.3	88829.5	88829.0	88830.0	88798.7	88797.7	88799.7
Generic	1064306.3	1064379.0	1064367.3	1064390.8	1064453.6	1064430.7	1064476.4
Percent Increase Over Base							
Lilydale	-	0.021	0.020	0.022	0.005	0.003	0.006
Maple Leaf	-	-0.034	-0.034	-0.033	-0.068	-0.069	-0.067
Generic	-	0.007	0.006	0.008	0.014	0.012	0.016

Table A24: Canadian Synthetic Model with Increasing Advertising Investment: Processor Market Share

	Base Model	Advertising Investment $750,000			Advertising Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
Processor	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Market Share by Dollars							
Lilydale	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Maple Leaf	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Generic	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Market Share by Quantity							
Lilydale	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Maple Leaf	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Generic	0.95	0.95	0.95	0.95	0.95	0.95	0.95

Table A25: Canadian Synthetic Model with Increasing Research Investment: Processor Market Share

Processor	Base Model	Research Investment $750,000			Research Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Market Share by Dollars							
Lilydale	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Maple Leaf	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Generic	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Market Share by Quantity							
Lilydale	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Maple Leaf	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Generic	0.95	0.95	0.95	0.95	0.95	0.95	0.95

Table A26: Australian Synthetic Model with Increasing Advertising Investment: Prices and Quantities

		Advertising Investment $750,000				Advertising Investment $1,000,000			
			95% Confidence Interval				95% Confidence Interval		
	Starting Values	Mean	Lower Bound	Upper Bound	Std Dev	Mean	Lower Bound	Upper Bound	Std Dev
Quantity (000's kg)									
q1	4948.1	4951.3	4951.2	4951.4	1.8E-01	4952.9	4952.8	4953.1	2.7E-01
q2	9402.3	9411.7	9411.4	9411.9	5.2E-01	9416.4	9416.0	9416.8	7.9E-01
q3	4872.6	4872.2	4872.2	4872.2	2.1E-02	4872.0	4872.0	4872.0	3.2E-02
q4	56004.3	56041.3	56040.3	56042.3	2.1E+00	56059.9	56058.4	56061.4	3.1E+00
q5	20097.4	20112.6	20112.2	20113.0	8.5E-01	20120.2	20119.6	20120.8	1.3E+00
Prices ($/dozen)									
p1	3.05	3.06	3.06	3.06	1.2E-04	3.06	3.06	3.06	1.8E-04
p2	3.11	3.11	3.11	3.11	1.3E-04	3.11	3.11	3.11	2.0E-04
p3	2.93	2.93	2.93	2.93	3.1E-05	2.93	2.93	2.93	4.7E-05
p4	2.20	2.20	2.20	2.20	9.6E-05	2.20	2.20	2.20	1.5E-04
p5	3.27	3.27	3.27	3.27	1.1E-04	3.27	3.27	3.27	1.6E-04
fp	1.07	1.07	1.07	1.07	4.0E-05	1.07	1.07	1.07	6.1E-05

qi and pi represent the quantities and prices specific to firm i, where i takes the values 1-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, and 5-Generic.
fp represents farm price

Table A27: Australian Synthetic Model with Increasing Research Investment: Prices and Quantities

		Research Investment $750,000	95% Confidence Interval			Research Investment $1,000,000	95% Confidence Interval		
	Starting Values	Mean	Lower Bound	Upper Bound	Std Dev	Mean	Lower Bound	Upper Bound	Std Dev
Quantity (000's kg)									
q1	4948.1	4950.3	4950.3	4950.4	1.1E-01	4953.0	4952.9	4953.1	2.3E-01
q2	9402.3	9405.3	9405.3	9405.4	1.5E-01	9409.0	9408.8	9409.1	3.1E-01
q3	4872.6	4876.9	4876.8	4877.0	2.0E-01	4881.9	4881.7	4882.2	4.4E-01
q4	56004.3	56036.5	56035.7	56037.2	1.5E+00	56074.9	56073.3	56076.5	3.3E+00
q5	20097.4	20107.4	20107.2	20107.7	4.8E-01	20119.5	20119.0	20120.0	1.0E+00
Prices ($/dozen)									
p1	3.05	3.05	3.05	3.05	4.5E-05	3.05	3.05	3.05	9.6E-05
p2	3.11	3.11	3.11	3.11	6.5E-05	3.11	3.11	3.11	1.4E-04
p3	2.93	2.93	2.93	2.93	1.8E-06	2.93	2.93	2.93	3.8E-06
p4	2.20	2.19	2.19	2.20	4.9E-05	2.19	2.19	2.19	1.0E-04
p5	3.27	3.26	3.26	3.26	5.2E-05	3.26	3.26	3.26	1.1E-04
fp	1.07	1.07	1.07	1.07	9.0E-05	1.06	1.06	1.06	1.9E-04

qi and pi represent the quantities and prices specific to firm i, where i takes the values 1-Sunny Queen, 2-Pace Farms, 3-Farm Pride, 4-Private Label, and 5-Generic.
fp represents farm price

Table A28: Australian Synthetic Model with Increasing Advertising Investment: Producer Returns

Base Model	Advertising Investment $750,000			Advertising Investment $1,000,000		
Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Net Return (000's of $)						
101996	14.4	10.7	18.1	83.6	78.0	89.3
Percent Return on Investment						
-	-94	-96	-93	-83	-84	-82

Table A29: Australian Synthetic Model with Increasing Research Investment: Producer Returns

Base Model	Research Investment $750,000			Research Investment $1,000,000		
Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Net Return (000's of $)						
101996	101748	101742	101753	101599	101596	101602
Percent Return on Investment						
-	-199	-201	-197	-179	-180	-179

Table A30: Australian Synthetic Model with Increasing Advertising Investment: Processor Returns

	Base Model	Advertising Investment $750,000			Advertising Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
Processor	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Net Return (000's of $)							
Sunny Queen	15091	15132	15131	15132	15142	15141	15143
Pace Farms	29240	29283	29281	29284	29308	29306	29311
Farm Pride	14275	14293	14293	14293	14294	14294	14294
Private Label	123209	123163	123159	123168	123253	123245	123260
Generic	65717	65706	65704	65709	65751	65747	65754
Percent Increase Over Base							
Sunny Queen	-	0.27	0.26	0.27	0.33	0.33	0.34
Pace Farms	-	0.15	0.14	0.15	0.23	0.23	0.24
Farm Pride	-	0.13	0.13	0.13	0.13	0.13	0.13
Private Label	-	-0.04	-0.04	-0.03	0.04	0.03	0.04
Generic	-	-0.02	-0.02	-0.01	0.05	0.05	0.06

Table A31: Australian Synthetic Model with Increasing Research Investment: Processor Returns

	Base Model	Research Investment $750,000			Research Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
Processor	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Net Return (000's of $)							
Sunny Queen	15091	15114	15113	15114	15116	15116	15117
Pace Farms	29240	29228	29228	29229	29224	29223	29225
Farm Pride	14275	14304	14303	14304	14318	14318	14319
Private Label	123209	122999	122996	123002	123016	123009	123022
Generic	65717	65629	65628	65630	65642	65639	65645
Percent Increase Over Base							
Sunny Queen	-	0.15	0.15	0.15	0.16	0.16	0.17
Pace Farms	-	-0.04	-0.04	-0.04	-0.05	-0.06	-0.05
Farm Pride	-	0.20	0.20	0.20	0.30	0.30	0.31
Private Label	-	-0.17	-0.17	-0.17	-0.16	-0.16	-0.15
Generic	-	-0.13	-0.14	-0.13	-0.11	-0.12	-0.11

Table A32: Australian Synthetic Model with Increasing Advertising Investment: Processor Market Share

	Base Model	Advertising Investment $750,000			Advertising Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
Processor	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Market Share by Dollars							
Sunny Queen	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Pace Farms	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Farm Pride	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Private Label	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Generic	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Market Share by Quantity							
Sunny Queen	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Pace Farms	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Farm Pride	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Private Label	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Generic	0.21	0.21	0.21	0.21	0.21	0.21	0.21

Table A33: Australian Synthetic Model with Increasing Research Investment: Processor Market Share

	Base Model	Research Investment $750,000			Research Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
Processor	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Market Share by Dollars							
Sunny Queen	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Pace Farms	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Farm Pride	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Private Label	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Generic	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Market Share by Quantity							
Sunny Queen	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Pace Farms	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Farm Pride	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Private Label	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Generic	0.21	0.21	0.21	0.21	0.21	0.21	0.21

Table A34: Sensitivity Analysis of Confidence Intervals Using Increasing Standard Deviations

	Standard Deviations at 100%[1]			Standard Deviations at 150%				Standard Deviation at 200%			
		95% Confidence Interval			95% Confidence Interval				95% Confidence Interval		
	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	% Change in Confidence Interval	Mean	Lower Bound	Upper Bound	% Change in Confidence Interval
					----------Producer Return on Investment----------						
Producer Selling to											
Lilydale	748	741	755	748	737	758	55.1	748	734	761	98.4
Maple or Generic	214	212	217	214	210	218	55.1	214	209	220	98.5
Canadian Average	217	214	220	217	213	221	55.1	217	212	222	98.5
					---------Processor Percent Over Base----------						
Processor											
Lilydale	0.406	0.403	0.409	0.406	0.401	0.411	55.1	0.406	0.400	0.412	98.4
Maple Leaf	0.274	0.272	0.276	0.274	0.270	0.278	55.1	0.274	0.269	0.279	98.4
Generic	0.164	0.162	0.165	0.164	0.162	0.166	55.1	0.164	0.161	0.167	98.4

[1] Standard deviation from the base model (100%) are 0.004 for advertising and 0.003 for research. These estimates of standard deviation, as presented by Brester and Schroeder (1995) and Alston, Marra, Pardey, and Wyatt (2000), are utilized to generate the standard errors used in the synthetic model.

As a side investigation, it is recognized that the Monte Carlo confidence intervals are rather narrow; in some cases rounding reveals no difference between the outer bounds and the mean. In this research these confidence intervals are generated from the assumed standard deviations on generic advertising and research elasticities. To investigate how sensitive these confidence intervals are to these assumptions a sensitivity analysis was carried out. In this analysis standard deviations as previous mentioned in section 5.1 were increased by 50% and then by 100%. The case investigated was Canadian fresh chicken with generic advertising increased by 50%. Canadian fresh chicken as it interacts with generic advertising was chosen for this analysis because it was the only industry action to consistently generates positive returns for producers. In the above table, it is illustrated that confidence intervals change by relatively the same amount as the increase in the assumed standard deviations. However, the confidence interval itself still remains rather tight. Producers can be confident in positive returns even when assumed standard deviations are doubled. Processors again remain only marginally influenced by increases in advertising. Confidence intervals may perhaps stay relatively small because of the small parameters used in the synthetic models, rather than the assumptions surrounding the choice of standard deviation.