RURAL ECONOMY

Canadian Chicken Industry: Consumer Preferences, Industry Structure and Producer Benefits from Investment in Research and Advertising

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Project Report

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Table of Contents

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Abstract

The Canadian chicken industry has operated under supply management since the mid-1970s. Canadian consumer preferences for chicken have grown dramatically since then possibly in response to concerns about health and the levels of fat and cholesterol in red meats. However Canadian consumers are also looking for convenience with their food purchases. Canadians are buying their chicken in frozen further processed forms, fresh by cut without skin and bone and in a variety of other different ways reflecting their unique willingness to pay for various attributes. There is also an increasing trend for retailers and processors to brand the fresh chicken product sold through grocery stores (for example, Maple Leaf Prime). The preferences Canadian consumer have for various chicken products, the prices they are comfortable paying and the strategies followed by processors/retailers can directly affect the outcomes of industry wide strategies such as investment in in generic advertising and research or the impact of international market changes such as border closures.

This research is an intial attempt to quantify Canadian consumer preferences – for fresh product by type – for product by level of processing – for chicken product by cut - for fresh chicken by brand - to examine the impact of substitutability on a variety of market shocks. The various different disaggregations of Canadian chicken consumption are used in a number of simulation models to illustrate how important preferences are to producer returns when there are market shocks. If Canadians found all chicken products available in the grocery store to be perfectly substitutable then previous policy analysis assuming chicken is one homogeneous product would be sufficient for industry policy analysis purposes. If Canadians view all the different chicken products as imperfectly substitutable and given that various chicken products are produced in relatively fixed proportions (white and dark meat, for example) further understanding of how consumers make their purchase decisions could enhance the industries ability to predict outcomes.

For example, border closing to Canadian exports (as a result of an Avian influenza outbreak, for example) would result in a significant increase in the dark meat products available for sale through Canadian grocery stores. The results presented in this research could provide a clue as to how much dark meat prices might decline while white meat prices might remain unafffected. The results reported suggest that at the consumer level, chicken fresh and frozen products are not perceived to be perfect substitutes, within a narrow category such as fresh chicken breasts, they are not perceived as even close substitutes, within the fresh category branded products such as those developed by Lilydale and Maple Leaf are not perceived as perfect substitutes. As well, an initial look at the demand for individual chicken products by household suggests that there is far from a common buying pattern across Canadian households, even within a single province.

The results also suggest that health and convenience attributes are driving Canadian consumer preferences. Simulation results highlight the fact that pricing strategies followed by major processors/retailers within Canada can influence the returns to generic adveritisng and research.

Further research could provide additional robust estimates of the chicken product substitutability existing in the Canadian market and an increased udnerstanding of the market characteristics currently operating. The results presented here suggest that further work in this area is important for the chicken industry to pursue.

JEL Codes: D12, Q11, Q18

Keywords: consumer behaviour, chicken consumption, differentiated products

Canadian Chicken Industry: Consumer Preferences, Industry Structure and Producer Benefits from Investment in Research and Advertising

BACKGROUND

This research project began in July 2003 with a grant from the Poultry Industry Council to examine returns to research and product development in the Canadian chicken industry. That funding was followed by a commitment of funding from the Co-operative Program in Agricultural Marketing and Business and a subsequent grant from the Alberta Livestock Industry Development Fund (to examine consumer demand for chicken products by product attributes). A large research grant on the socio-economic impact of BSE (from the Alberta Prion Research Institute in 2006) ultimately provided the means where a very detailed data set on household purchases of meat products for a five year period allowed us to undertake some of the sophisticated consumer demand analysis.

The initial objective of the research was to empirically examine the market structure of the Canadian chicken market. This objective includes modeling consumer demand and processor strategic conduct for individual products competing in an oligopolistic market. Apart from aggregate disappearance, consumer behaviour was to be examined around a number of different characteristics including:

- attitudes towards each of the following attributes: food safety, nutrition, animal welfare and the environment
- through revealed preference methods characterize individual consumer purchase decision using food diary data

The estimated models of consumer behaviour, processor behaviour and farm level decision making can be used to analyze the size and distribution of benefits from producer investments in advertising and research under existing market structures. As well, policy and planning for the industry can be based on a more complete characterization of consumer preferences.

The live stock industry has been and still is today a major contributor to the gross domestic income of Canada. Recently, the livestock industry has seen a disproportionate share of challenges with respect to consumers' perceptions; food safety concerns (domestically and internationally); transitions in environmental policy; changes in production practices and technology; and product innovation to encourage the continuing growth of consumption of chicken. In recent years there has been a significant industry led/consumer oriented drive to put innovative value-added products on retail shelves. Value-added products provide consumers with a wider range of food products that address concerns of food safety, nutrition, and quality. The poultry industry has taken a significant leadership role in this era of product differentiation and quality innovation. Many of these products contain credence attributes making it difficult, if not impossible, for consumers to detect the quality attributes and claims in pre-purchase and post purchase evaluations (Hoffman, 2000). In dealing with these challenges the poultry industry must find ways to increase the engagement of consumers within the food chain and to provide effective avenues to aid consumers in their evaluation of products attributes and claims (Korthals 2001). Industry supported initiatives must be undertaken to quantitatively and qualitatively assess the influence consumers perceptions, beliefs, and attitudes have on product evaluation and purchasing decisions (Sunding et al. 2003).

Recent outbreaks of animal transmitted diseases (BSE and avian flu); advancements in biotechnology and genetic engineering; and food borne illness scares (i.e. salmonella and ecoli bacteria) have helped to underscore consumer perceptions of food safety as one of the major challenges facing the livestock industry. Consumer perceptions of the perceived risks and dangers associated with livestock commodities has dominated debates concerning food safety issues (Myhr and Traavik, 2003).

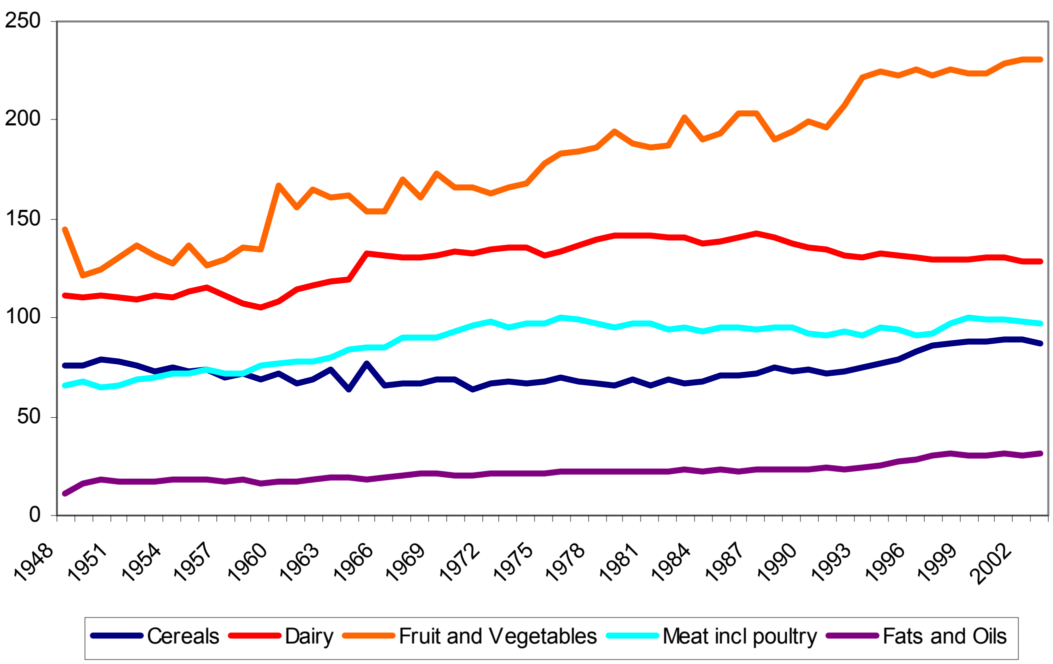
Increased general public awareness of the relationship between diet and lifestyle related diseases (i.e. obesity, cardiovascular disease, and cancer) have resulted in an increase consumer scrutiny of traditional nutritional aspects of food (i.e. fat, fibre, salt, and vitamin content) and nontraditional nutritional attributes of food (i.e. Omega-3 content) (Urala and Lahteenmaki, 2003).

Given this context of evolving consumer preferences the development of numerous chicken products is not too surprising. However the development of these products, usually by processors, and the resulting distribution economic benefits from increasing the number of chicken products available will depend crucially on market structure. Market structure can also affect the returns to traditional industry led investments in advertising and research. This research will shed light on changing consumer demands for chicken products and the implications of those changing demands on market participants, highlighting the impact for chicken producers.

Overview of the chicken market in Canada.

Canadian food consumers have an abundant opportunity to select among many different foods, this availability and evolving tastes and preferences have resulted in major shifts in food disappearance on a per capita basis over time. For example, fruits and vegetables have increased dramatically. Meat's role in overall food per capita consumption is highlighted in the Figure 1.

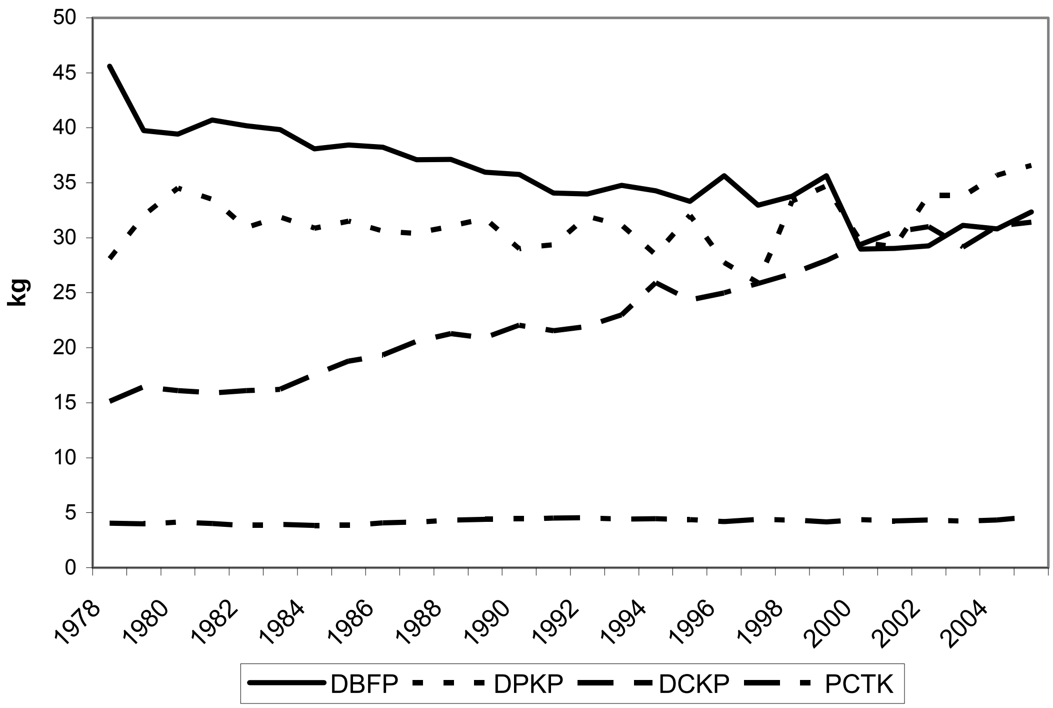
Figure 1. Per Capita Food Disappearance



Source: Statistics Canada (disappearance and trade)

With a disaggregation of meat disappearance into different animal species it becomes clear that the relatively flat trend in per capita meat consumption is generated by relatively dramatic changes in individual meats consumed, decreases in beef consumption and increases in chicken consumption (Figure 2). Chicken disappearance has been increasing since the 1980's. The chicken market benefited from increasing nutritional concerns about cholesterol since consumers tended to shift away from red meats towards 'white' meat in response to these widely publicized health concerns.

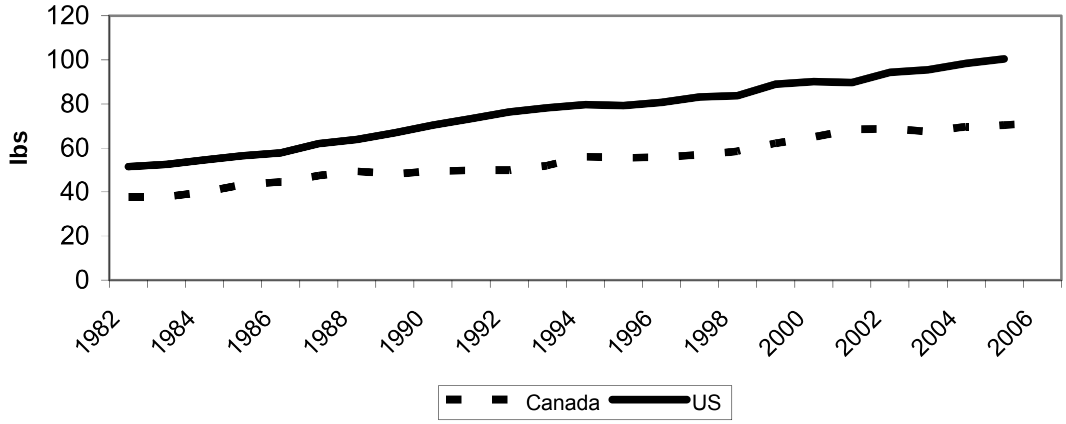
Figure 2. Annual Meat Disappearance, Per Capita, Canada



Source: Statistics Canada (disappearance and trade)
(DBFP=beef, DPKP=pork, DCKP=chicken, PCTK= turkey)

Even with this increasing trend in total chicken disappearance, Canadian chicken disappearance on a per capita basis remains significantly lower than that in the U.S. This is similar to the trend in most meat products where per capita disappearance remains lower in Canada than in the United States (Figure 3).

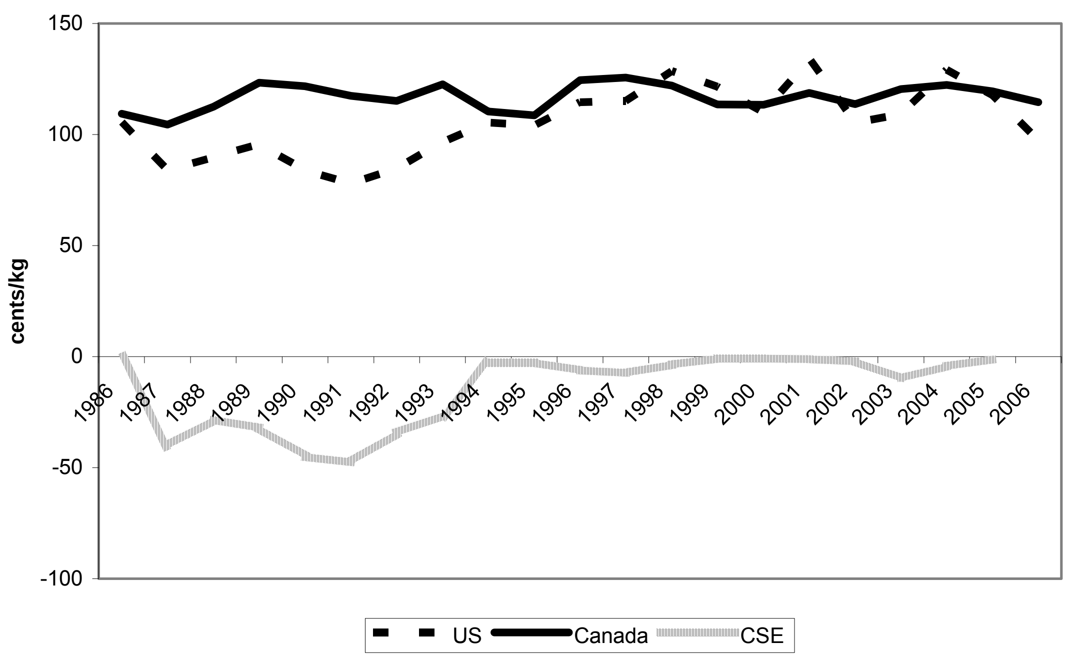
Figure 3. Chicken, Per Capita Consumption, pounds



Source: Statistics Canada and USDA

For many years economists have explained the differences in per capita chicken consumption between Canada and the U.S on the basis of significantly different prices, arising from supply management in the Canadian market. Recent price movements at the farm level show little evidence of differences across countries, reflected in a measure of consumer support estimate that is very close to zero for much of the period since 1995.

Figure 4. Chicken Prices, US and Canada, CSE



Source: Chicken Farmers of Canada, USDA and OECD

Canada's poultry industry operates under a supply management system. Supply management was originally set up by farm groups to address issues of price and income stability. In 1970, supply management 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 Canadian Chicken Marketing Agency (now 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 September 2003 there were 167 (135 in 1998) primary processing plants, of which 59 (63 in 1998) were federally inspected and 108 (72 in 1998) provincially inspected. Of these 167 plants the five largest companies: Flamingo Foods (Coopérative fédérée de Quebec), Lilydale Poultry Cooperative, Maple Leaf Poultry, Exceldor, and Maple Lodge Farms, accounted for 55% of the poultry processed in Canada. Maple Leaf is considered the single largest firm. It is note worthy that the list of industries leaders includes three producer cooperatives, Lilydale Poultry Cooperative, Flamingo Foods (owned by Coop

Fédère) and Exceldor (Quebec coop created through the acquisition of and merger with Dorchester Cooperative; Saint-Damase Cooperative; La Poulette Grise; Produits Quatre Étoiles and Laurentian Regional Poultry Processing Plant). 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 member welfare through a combination of 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. The four largest Canadian retailers have 60.05% of the total Canadian grocery market. Unlike the processing sector, the retail sector is not marked by major cooperatives with the exception of the Co-op chain at 3.58% market share.

Table 1. Grocery Sales and Market Share for Canada's Retailers: 2002.

Canadian Grocery Retailer	Billion $	Can Market Share
Loblaw	23,894	32.03%
Sobeys	10,960	14.69%
Safeway	5,492	7.36%
Metro	5,201	6.97%
Overwaitea	2,380	3.19%
A&P	4,400	5.90%
C-Store	3,250	4.36%
Costco Food	3,550	4.76%
Drug	2,659	3.56%
Wal-Mart	2,758	3.70%
Co-Op	2,667	3.58%
Mass Merc., Indep, others	7,389	9.90%
Total	74,600	100.00%

Source: *Canadian Grocer* 2003-2004 Executive Report.

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 (including Janes, Flamingo and Schneiders). Recently the major national processor, Maple Leaf, has been aggressively pursuing a strategy of 'branding' fresh product (Naturally Prime) based on production attributes and identifying labels. Lilydale, a major western Canadian chicken processor has followed a similar strategy with their Llydale Gold brand for fresh chicken. 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.

Processors and retailers in the Canadian chicken market must satisfy final consumers from domestic supply plus imports (in many cases processors and retailers are the 'owners' of importing rights). Since the WTO in January 1995, traditional import quotas have been transferred into tariff rate quotas and imports have been gradually increasing. At the same time the chicken industry has pursued a strategy of encouraging exports. From Figure 5 the developing trends in imports and exports to and from the Canadian chicken industry are clear. Chicken imports are growing at the industry agreed upon rate (under trade regulations) while there has been a dramatic increase in exports over the past 12 years.

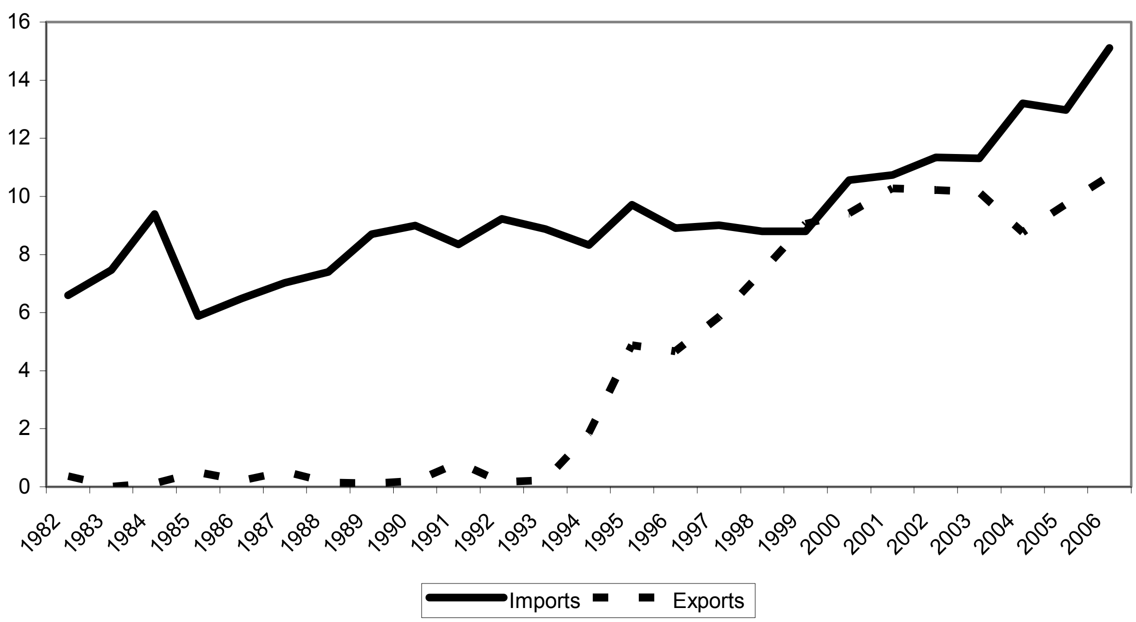
Table 2: Canadian Exports of Chicken Products, Various Years

	1997	2001	2006
Chicken / Poulets		kg	
Live (Evis. Wt.)	N/A	N/A	N/A
Carcass	**1,378,002**	**1,969,565**	**82,487**
Bone-in breast, raw	**0**	**1,436**	**2,502**
Bone-in legs, raw	**0**	**48,407,886**	**38,083,168**
Bone-in wings, raw	**0**	**3,012,175**	**2,417,422**
Bone-in parts	**29,789,865**	**740,285**	**1,680,100**
Boneless breast, raw	**0**	**3,703**	**130,611**
Boneless, burgers, strips, nuggets	**1,121,243**	**68,392**	**308,606**

Boneless parts	**488,293**	**209,031**	**138,872**
Others Bone-in	**11,099,811**	**10,654,649**	**3,506,547**
Others Boneless-MSM	**10,181,848**	**13,607,091**	**16,216,865**
Others Boneless-Giblets	**1,225,827**	**446,318**	**127,511**
Others Boneless	**1,317,350**	**316,199**	**1,488,593**
Total	**56,602,239**	**79,436,730**	**64,183,284**

Source: Agriculture and Agri-Food Canada, Poultry Market Review, various issues

Figure 5: Chicken Imports and Exports as a Percentage of Domestic Production, Canada



Source: Chicken Farmers of Canada Databook

Research Statement

The Canadian chicken market has recently been facing significant changes, consolidation in Canadian processing and retailing, changing trade agreements, increasing imports and dramatically increasing exports, and evolving Canadian consumer preferences for different types of chicken products. The research in this report attempts to provide an empirical assessment of many of these changes with simulation modeling used to highlight the important of any measured relationships for industry strategy. Evolving consumer preferences within Canada will be measured using:

Alberta household purchases of chicken by product type (fresh, processed parts, meal(kabobs etc.), burgers, nuggets and strips, wings) – linked to prices and household demographics – using household purchase data for 2005.

Canadian preferences for types of chicken breasts (boneless, skinless etc.) – linked to prices, nutrition attributes – using national scanner data

Canadian preferences for chicken product type (23 fresh and frozen products) – linked to prices to establish substitutability among types – using national scanner data.

All of these measures of consumer preferences are new to the Canadian literature. The demand for chicken product by type will provide the basis of a synthetic simulation model of the entire Canadian chicken market used to examine the impact of exogenous factors – changes in beef prices, reductions in volume of exports – on Canadian chicken producers, consumers, processors welfare. The model will capture both Canadian consumer preferences by product and the joint nature of chicken products produced in the marketplace (relatively fixed ratios of dark to light meat).

The changing structure of the Canadian chicken market will be examined using a game theoretic model of pricing interactions for fresh branded chicken products. Actual data on how major firms play pricing games will provide the basis for an examination of the impact of industry research and advertising investment given the empirically established structure of the Canadian industry. Future planning for strategic development in the industry can be enhanced through the simulation analysis reported.

CANADIAN CHICKEN CONSUMPTION

Revealed Preference Analysis: Alberta

One type of analysis that can be conducted to examine consumer preferences for chicken, at the household level, is revealed preference analysis. This analysis makes use of actual household or individual purchase data, recorded over time by panels recruited by market research companies (occasionally similar analysis is undertaken by organizations such as Statistics Canada, but their samples are usually one-off and do not contain a history of purchases for the same household). In this research AC Nielsen Homescan ©
data was purchased on all meat products for Canada for five years, 2001-2005. The data contained all individual meat purchases, classified by size, by package size, by brand and by type. As well household demographic data, including average age of head of household, number of children, income for each household, education, language spoken were also recorded.

For the reported analysis the chicken products purchased by households in Alberta were the focus. These households' annual purchases were identified for the year 2005. In total 703 households were observed in Alberta, who purchased chicken in the year 2005. It is noteworthy that the full data set included more than chicken purchases. There are an enormous number of meat products purchased through grocery stores including fresh products of all types, processed products, deli products both through the deli counter and through the store shelves. However, for this analysis the study was limited to purchases of chicken, with all purchases across a year aggregated into a single purchase of each of six chicken product types. Five choice alternatives were identified: (1) fresh chicken (aggregated in this sample from all individual fresh chicken products) (2) processed chicken parts (breaded breasts etc.) (3) chicken meal products (kabobs etc.) (4) chicken burgers (5) chicken nuggets and strips and (6) chicken wings. These products were aggregated into groups from a variety of individual branded products.

One of the tasks involved in using panel data is with the construction of the vector prices faced by each consumer on each purchase occasion. The basic problem is that one only observes the price paid by the consumer for the chicken products that he/she actually purchased. Prices for other products are inferred. If it was the case that a panellist did not purchase any of the alternatives during the year, we used the average price of that particular chicken product experienced by other panellists as the price that he or she could have faced had he/she decided to purchase a particular chicken product. Baltzer (2004) used a similar approach when he was faced with the missing values for price. Baltzer argues that this solution has the advantage of being theoretically plausible as well as having no impact on the parameter estimates.

Table 3. Average Prices for the Chicken Products, Alberta

Chicken Product Type	Mean
$/lb	Alberta
Fresh	3.94
Processed	8.13
Meal	11.82
Burger	5.69
Nuggets and Strips	8.67
Wings	7.38

Table 3 shows the average price of processed chicken products to be much higher than fresh. The higher prices associated with the further processed chicken products may be a reflection of additional costs involved in partially preparing products, closer to final consumption.

Data Setup for Multinomial Logit Model with Number of Purchase Occasions Per Chicken Product Type as the Dependent Variable

In this data set up, the frequency decision was used as the dependant variable. The chicken products purchased were summed up across all time periods for product type, for 2005, creating a frequency variable (number of purchases by type). A summary of chicken types purchased are shown in Table 4.

Table 4. Chicken Product Purchases Per Household: Alberta

Chicken Product Type	# of Households	Minimum	Maximum	Mean	Std. Deviation
Fresh (number of times)	650	0	46	7.53	6.68
Processed (number and weight)	300	0	105	11.63	12.38
Meal (number and weight)	27	0	10	2.56	2.25
Burger (number and weight)	94	0	86	5.61	9.76
Nuggets and strips (number and weight)	139	0	35	5.18	5.37
Wings (number and weight)	141	0	93	6.42	9.84

Table 4 shows that most households purchased fresh chicken for 2005. 300 households purchased a lot of processed chicken products (chicken breast breaded or in sauce, for example). Only 27 households purchase the highly processed chicken meal type item. Approximately 100 households purchase burgers, nuggets and wings. There is a large variability in the volume of product purchased by each household as evidenced by the high standard deviations.

Conditional Logit Model with Frequency as the Dependant Variable

The dependant variable frequency is equal to the total volume of chicken products purchased for 2005. By using frequencies, one can account for the multiple product purchases by a household at one purchase occasion.

In the conditional logit model postulated, chicken product purchase by type is assumed to be dependent on a set of socio-economic variables and prices of the different chicken products. The estimated coefficients β_j for all $j(j = 1,.....J)$, after normalizing the "normal alternative" $j = 0$, measure the effect of the explanatory variables in the indirect utility function on the likelihood of choosing chicken product type i relative to the "normal option". In this case chicken burger was chosen as the normal option. Estimates from the equation are reported in Table XXXX. Estimates with a negative sign imply the preference for the "no purchase" option while estimates with a positive sign imply the preference for a particular type of chicken product.

Table 5. Conditional Logit Regression Estimates for Frequency Model Alberta

Variable	Parameter	t-values
PRICE	-.4567**	-5.98
Fresh Chicken		
Household Income	-.0003	-.043
Presence of children	-.335	-1.54
Education	.431**	10.155
Price	.545**	7.23
Processed Chicken		
Household Income	-.013*	-1.79
Presence of children	.524*	2.22
Education	.215**	4.68
Price	.348**	4.49
Chicken Meal		
Household Income	-.037*	-1.78
Presence of children	-.006	-.009
Education	.08616	.795
Price	-.074	-.474
Nuggets and Strips		
Household Income	-.025*	-2.73
Presence of children	1.19**	4.212
Education	.211**	3.906
Price	.121	1.36
Wings		
Household Income	-.0357**	-4.06
Presence of Children	.919**	3.34
Education	.0394	.733
Price	.422**	5.209
Log-likelihood		-6021.47
Number of observations		703
χ^2 (15)		25.00

**** p < .05 * p < .10**

For Alberta, the price coefficient is negative and significant, indicating that increasing price decreases the probability of a household purchasing any chicken product. Price interactions with alternative specific constants are also included in the model, highlighting that demand for fresh chicken at the household level is extremely inelastic (summed coefficient almost equal to one). The coefficient on the income variable is negative and significant for all of the types of chicken product, suggesting a lack of growth potential as incomes grow (relative to the omitted product chicken burgers).

The coefficients on the presence of children are positive and significant for the majority of the processed chicken products, possibly suggesting the need for convenience in households with children present. The coefficients on education are positive for many of the chicken products, with the largest coefficient on fresh chicken. Perhaps the additional education is linked to an increased understanding of health attributes associated with each of the chicken products and consumers are trying to avoid some of the attributes (salt, fat) that accompany processed products.

Willingness to Pay Revealed Preference Analysis

From the revealed preference analysis willingness to pay for a certain type of chicken product can be calculated from the regression coefficients. These numbers are shown in Table 6.

Table 6: Calculated Willingness to Pay, at the mean of all explanatory variables

Chicken Product Type	Alberta
$/lb	
Fresh Chicken	0.82
Processed Chicken	1.02
Chicken Meal	-.45
Nuggets and Strips	1.15
Wings	1.13

From the willingness to pay, which allows the chicken product comparison, there are not large differences in preferences for the various chicken products, relative to the excluded product, chicken burger. The value can be interpreted as follows: consumers would be willing to pay $.82 more than the current price for fresh chicken ($3.94) to receive equal utility to chicken burger. Clearly the chicken meal type items, which have the most processing, appeal to a limited cross section of the population. The processed chicken pieces (including both flavoured and breaded products), nuggets and strips and wings share a very common willingness to pay, that is slightly higher than fresh chicken's WTP above chicken burgers. Different aggregations of the various chicken products by nutritional content similarities (there are some categories such as processed chicken which could be further subdivided by the type of processing) could further illuminate nutritional attributes and determine willingness to pay on that basis. Comparisons to the data for other provinces may be interesting since previous data on eggs has shown some significant differences between preferences in Alberta and Ontario.

Aggregate Analysis Of Chicken Breast Consumption By Type: Canada

An AC Nielsen Market Track © data set on fresh and processed chicken products for Canada from mid 2000 to late 2003 was examined to quantify the demand for chicken breasts. Increasingly fresh chicken products are being sold in grocery stores in a variety of forms – without skin, without bone, without either. Some of the nutritional concerns associated with chicken concern the level of fat that is found within the skin. If consumers are becoming increasingly health conscious then are they willing to pay more over time for the additional effort involved in removing skin from chicken pieces before purchase. Does the additional removal of bones add to the value or appear to be an attribute that consumers in general are looking for?

One source of information about the nutritional attributes of individual chicken breast products is the USDA National Nutrient Database for Standard Reference (http://www.ars.usda.gov/main/site_main.htm?modecode=12-35-45-00). For two types of chicken breast – with skin and without skin, the nutrients associated with the edible portion are presented in Tables 7 and 8. There is a relatively dramatic difference in the total lipid (fat) associated with each product. However the nutritional content of the raw chicken breast is only one part of the 'healthy' nature of the product, the cooking method used in final food preparation can significantly affect the final nutritional quality of the food product.

Table 7 Chicken, broilers or fryers, breast, meat and skin, raw: Nutrient Value

Nutrient	Units	Value per 100 grams	Number of Data Points	Std. Error
Proximates				
Water	g	69.46	29	0.278
Energy	kcal	172	0	
Energy	kj	720	0	
Protein	g	20.85	29	0.148
Total lipid (fat)	g	9.25	29	0.243
Ash	g	1.01	29	0.058
Carbohydrate, by difference	g	0.00	0	
Fiber, total dietary	g	0.0	0	
Sugars, total	g	0.00	0	

Source: USDA

Table 8 Chicken, broilers or fryers, breast, meat only, raw: Nutrient Value

Nutrient	Units	Value per 100 grams	Number of Data Points	Std. Error
Proximates				
Water	g	74.76	31	0.228
Energy	kcal	110	0	
Energy	kj	460	0	
Protein	g	23.09	32	0.194
Total lipid (fat)	g	1.24	40	0.086
Ash	g	1.02	28	0.025
Carbohydrate, by difference	g	0.00	0	
Fiber, total dietary	g	0.0	0	
Sugars, total	g	0.00	0	

Source: USDA

Empirical Analysis

The data on sales of chicken breasts by type for Canada over the period 2000 to 2003 were analyzed using a linear version AIDS two stage demand system. Although meat demand scanner data studies can use any type of functional form the Rotterdam model

(Nayga and Capps, 1994) and the AIDS model (Eales and Unnevehr, 1988) are two common ones. The AIDS model satisfies the axioms of consumer choice and allows for consistent aggregation of micro-level demands up to a market-level demand function (Eales and Unnevehr, 1988). There are a number of heroic assumption underlying the specification of a two stage demand model, such as the products identified in the model are weakly separable from all other products, in this case other chicken products, other meats and all other goods**.** In essence it is possible to separate the consumer choice model for the selected goods from all other products consumers purchase.

The general form of the first stage total expenditure equation is:

$TEXP_i = \sum_i P_iQ_i = f\ (PSTAR, TIME, TEXP(-1))$

i = 1,2,…,n. individual products

P_i = real price of individual chicken breast products i
Q_i = quantity consumed of chicken breast product i
PSTAR= expenditure share weighted price index for all types of chicken breast products;
TIME= time trend
TEXP(-1) = lagged total expenditure one period.

The general form of the second stage equations of the AIDS model share equation is:

$$\omega_i = \alpha_i + \Sigma_j \gamma_{ij} \ln (p_j) + J_iQt(-1) + B_iTEXP + X_iTime + \beta_i In(TEXP/P)$$

where ω_i = expenditure share on the i^{th} commodity
p_j = are commodity prices
Qt(-1) = lagged quantity
TEXP = total expenditure
TIME = time .

and

$$\ln(P) = \alpha_0 + \Sigma_j\alpha_i\ln(p_i) + ½\ \Sigma_i\ \Sigma_j\ \gamma_{ij}\ \ln(p_i)\ln(p_j).$$

Applying the basic demand restrictions of homogeneity, adding up, and symmetry directly on the parameters of the model we get:

$\Sigma_i\alpha_i= 1 \quad \Sigma_i\gamma_{ij} = 0 \quad \Sigma_i\beta_i = 0$ adding-up
$\Sigma_j\gamma_{ij} = 0$ homogeneity
$\gamma_{ij} = \gamma_{ji}$ symmetry

which can be tested or imposed.

To simplify estimation the nonlinear price term is replace by the Stone index or PSTAR from the first stage equation described above. Both first and second stage equations include terms for habit formation and time trends. Other explanatory variables such as prices of other chicken products, other meat products advertising are not included in this initial analysis because the analysis is conducted at such at a disaggregated level.

There are eight different types of fresh chicken breast to be found in the scanner data on sales within Canada, including:

Bone-in Skin-on, Bone-in Skinless, Bone-in Unspecified, Boneless Skin-on, Skin-on Bone unspecified, Skinless Bone Unspecified, Remaining. It is clear from this list that there are a few types of chicken breast that clearly cannot be classified as 'healthier' than others due to lack of information on whether they are skin on or not. The mean quantities and prices of the eight products are shown in Table 9 below.

Table 9: Aggregate per Capita Quantity Consumed and Mean Price over 160 weeks, 2000-2003

Product	Per Capita Quantity kg	Mean Price $/kg
All chicken breast	5.12	11.07
Bone in Skin on	1.59	9.85
Bone in Skinless	.33	7.79
Bone in Skin unspecified	.07	12.55
Boneless Skin on	.40	13.30
Boneless Skinless	2.07	12.62
Skinless bone unspecified	.20	8.63
Skin-on bone unspecified	.07	7.47
Remaining	.39	11.01

From the table there is wide variability in the consumption levels of the various products with the remaining (or more likely unspecified) category representing a fairly large share. Prices may reflect the additional work involved in preparing the fresh product for sale, with the boneless product selling at the highest prices for the category.

The results from estimation are highlighted in the Price (Table 10), Substitution Elasticity (Table 11) and Time Trend (Table 12) tables to follow. The price elasticities show very elastic responses to own price (as would be expected from this very disaggregated data). However the expenditure elasticities (showing how much expenditure will be spent on each individual good if expenditure on all chicken breasts increased by 1 %) highlight some dramatic differences between the various types of chicken breasts. Two products identified as skinless have some of the highest expenditure elasticities. There seems to be somewhat less interest in the boneless category with the boneless skinless chicken breast, a relatively small and expensive category only having an expenditure elasticity of approximately 1, as compared to other skinless categories with expenditure elasticities of over 2. In the table presenting Substitution elasticities the vast majority of the different types of chicken breast are shown to be net substitutes, signifying that consumers are willing to substitute one for the other as relative prices change. The table presenting the time trend coefficients shows first of all that there is a discernable trend upward in chicken breast consumption even over a three year period. Second the time trend coefficients on some skinless products are some of the largest, signifying that over this period these skinless categories were growing the fastest.

Table 10: Price Elasticities Across Two Stages of the Demand System, Expenditure Elasticities (Second Stage)

	Bone-in, Skin-on	Bone-in Skinless	Boneless Skin unspecified	Boneless Skin-on	Boneless Skinless	Skin-on Bone unspecified	Skinless Bone Unspecified	Remaining	Expenditure
Bone-in Skin-on	-.86 (7.09)	.37 (3.45)	1.005 (3.31)	.08 (1.29)	-.12 (-1.19)	.46 (3.08)	1.93 (3.40)	.13 (2.13)	.56 (5.40)
Bone-in Skinless	.03 (.16)	-3.27 (-21.00)	-.30 (-4.05)	-.02 (-.15)	.65 (3.03)	.06 (1.04)	-.19 (-2.88)	-.26 (-2.18)	2.74 (17.29)
Boneless Skin unspecified	-.09 (-.34)	-.51 (-2.71)	-1.31 (-7.82)	.47 (2.24)	-.38 (-1.09)	-.36 (-3.61)	-.23 (-2.64)	.08 (.36)	2.24 (8.50)
Boneless Skin-on	.05 (.40)	.09 (1.60)	.16 (3.11)	-1.92 (-18.26)	.72 (5.17)	.06 (1.94)	.17 (2.28)	.12 (2.15)	.63 (5.29)
Boneless Skinless	-.43 (-4.64)	-.38 (-2.10)	-.98 (-2.22)	-.24 (-2.23)	-1.53 (-17.26)	-.55 (-2.31)	-1.58 (-2.00)	-.38 (-3.33)	1.11 (18.96)
Skin-on Bone unspecified	-.08 (-.92)	.21 (2.63)	-.20 (-3.88)	.05 (.72)	.78 (6.37)	-2.54 (-30.81)	.15 (2.85)	-.19 (-1.87)	1.64 (19.93)
Skinless Bone unspecified	-.13 (-.48)	.05 (.22)	-.39 (-2.40)	.12 (.55)	1.35 (3.66)	.68 (3.77)	-3.15 -14.65)	-.75 (-2.42)	2.16 (8.67)
Remaining	.07 (.88)	-.06 (-.98)	.03 (.79)	.13 (1.97)	.05 (.41)	-.06 (-1.60)	-.05 (-1.45)	-1.09 (-10.55)	.83 (10.54)

Table 11: Substitution Elasticities at the Second Stage of the Demand System

	Bone-in, Skin-on	Bone-in Skinless	Boneless Skin unspecified	Boneless Skin-on	Boneless Skinless	Skin-on Bone unspecified	Skinless Bone Unspecified	Remaining
Bone-in Skin-on	-2.22 (-6.32)	2.92 (5.49)	1.94 (2.14)	.95 (2.46)	.53 (2.75)	1.40 (4.88)	1.71 (1.93)	1.20 (4.29)
Bone-in Skinless		-75.60 (-19.88)	-9.94 (-2.15)	2.93 (2.29)	4.20 (9.05)	7.16 (3.76)	3.58 (.59)	-.08 (-.05)
Boneless Skin unspecified			-83.45 (-7.55)	7.37 (3.35)	1.44 (1.88)	-9.73 (2.85)	-22.91 (-2.17)	3.37 (1.22)
Boneless Skin-on				-19.80 (-18.06)	2.29 (7.42)	2.37 (3.20)	3.50 (1.52)	2.54 (3.70)
Boneless Skinless					-1.69 (-11.25)	3.37 (12.48)	5.13 (6.21)	1.01 (4.02)
Skin-on Bone unspecified						-83.96 (-30.16)	25.66 (4.17)	-.62 (-.47)
Skinless Bone unspecified							-380.25 (-14.54)	-7.67 (-1.89)
Remaining								-13.22 (-9.80)

Table 12 : Regression Coefficients on Time Trend in Various Equations

Equation	Regression Coefficients on Time Trend
Bone-in	-.71
Skin-on	(-3.25)
Bone-in	.0001
Skinless	(2.56)
Boneless	-.00
Skin unspecified	(-.94)
Boneless	.0001
Skin-on	(1.62)
Boneless	.00
Skinless	(1.11)
Skin-on	-.0001
Bone unspecified	(-6.32)
Skinless	.12
Bone unspecified	(7.74)
Remaining	.59
Expenditure on Chicken Breast	.0004
	(2.25)

Canadian Chicken Aggregate Demand Analysis by Product Type[1]

This section will present a detailed conceptual and empirical framework that will be used to complete the analysis of Canadian chicken consumption, in aggregate, by chicken product type. Weak separability is a necessary and sufficient condition for the assumption that consumer follow a two stage budgeting procedure. It allows for the disaggregation of products into groups where the marginal rate of substitution between goods in the same group is independent of the quantities being consumed in other groups. In the first stage of a multi-stage budgeting process a consumer will allocate income across broad commodity groups such as (food, clothing, shelter etc.). Then in successive stages further allocations of income within the broad commodity groups are made until the decision gets down to individual commodities. The stages of the decision process are conducted as if they are a simultaneous utility maximization procedure (Deaton and Muellbauer, 1980).

The study of Canadian chicken demand will be based on the assumption that at the first stage meat is separable from all other goods and at the second stage chicken is separable from all other meats, these are maintained assumptions. The dependant variable in the first stage of the demand system is specified as the log of total expenditure on chicken as a function of a set of logged independent variables such as prices of the different chicken products, other meats, personal disposable income, and seasonal dummy variables (the seasonal dummies are not logged). As well, there have been a number of exogenous shocks to the meat demand system and previous research (Lomeli, 2005) has shown that food safety media coverage, as well as animal disease media

[1] The material in this section is largely taken from an unpublished Masters thesis by Christopher Panter, 2005.

coverage both have the potential to affect consumer demand. In this case these factors, relevant to chicken, will be included in the aggregate demand for chicken equation. The general form of the first stage total expenditure equation is:

$$TEXP_i = \sum_i P_iQ_i = f(PSTAR,PB,PP,INDEX,PDI,BSE,TEXP(-1),SD)$$

i = 1,2,…,n. individual products

P_i = real price of individual chicken products i

Q_i = quantity consumed of chicken product i

PSTAR= expenditure share weighted price index for all types of chicken products

PP= price of pork

PB= price of beef

INDEX= food safety index

PDI= personal disposable income

BSE= BSE dummy variable

TEXP(-1) = lagged total expenditure one period

SD= seasonal dummy variables

Variables will be dropped in estimation based on significance of variable coefficients and to obtain significance and correct signs on critical variables such as price. The expenditure weighted price index (P) is a Stone price index and is linear, facilitating easier estimation of the AIDS model. The scanner data provides very detailed price and quantity information for specific products, with many products, so simplifying aggregations are made to make the dataset manageable. The basic aggregated groups in the fresh and frozen categories are estimated in the second stage of the demand system. In the second stage it is a maintained assumption that chicken is separable from all other meats so that when the decision has been made to buy chicken the consumer is only faced with different product choices consisting of chicken. At the second stage of the model a system of share equations illustrating the demand for each type of chicken product as a function of the goods' own price, prices of other chicken products, total expenditure, seasonal dummies and time. Other variables such as the food safety index, BSE, are also included and tested:

$$w_i = P_iQ_i/TEXP = g(P_i, TEXP, SD, Time) \quad i = 1,2,\ldots,n. \text{ individual products.}$$

Within Canadian chicken demand the broad categories of chicken products are frozen (further processed) and fresh. Brand information exists for all of the frozen products and some of the fresh. The remaining fresh chicken is generic and is not given a brand name in the dataset. It is far too complicated to attempt estimation of a demand system for all the products identified through their respective brands so major chicken product categories are estimated instead. Many of the products are relatively new and were not offered for sale during some period in the data and other specific products were discontinued over the estimation period. Therefore, estimation will be attempted on the major product groupings highlighted in the AC Nielsen Market Track© data. In both the fresh and frozen categories, variables are created that take into account products that do not fit well in any of the defined categories. These variables are titled *mix* (short for mixture) in the frozen group, and *ast* (short for assorted) in the fresh group.

Previous studies by Eales and Unnevehr (1988) and Nayga and Capps (1994) break down chicken products into whole birds and fresh plus further processed parts, and breasts, parts, and other chicken respectfully. Since our study only looks at chicken a more detailed breakdown is possible. The following table provides a summary of the variable names and abbreviations plus the number of individual chicken products that were aggregated to form that variable.

Table 13. Table of Aggregated Chicken Product Variables from the ACNielsen Scanner Data.

Product Group	Variable Abbreviation	Percent Share of Total Chicken	Number of Individual Products	Frozen or Fresh
Premium priced breaded formed chicken	PBFC	4.5%	76	Frozen
Value priced breaded formed chicken	VBFC	0.8%	13	Frozen
Breaded natural chicken	BNC	1%	31	Frozen
Flavored chicken breasts	FCB	0.5%	28	Frozen
Un-flavored chicken breasts	UFCB	2%	30	Frozen
Chicken wings	WNGS	3%	64	Frozen
Stuffed chicken	SC	0.3%	11	Frozen
Un-breaded chicken burgers	BUGU	0.5%	15	Frozen
Breaded chicken burgers	BUGB	0.9%	25	Frozen
Breaded chicken parts	PART	0.08%	13	Frozen
All other frozen chicken	MIX	1.2%	56	Frozen
Whole chicken	whole	21%	56	Fresh
Breast	brst	24%	116	Fresh
Drumsticks	drum	7.7%	28	Fresh
Wings	wing	4.2%	33	Fresh
Burger	burg	0.08%	3	Fresh
Legs	legs	13%	33	Fresh
Winglettes	wingt	0.1%	4	Fresh
Kabobs	kabob	0.3%	4	Fresh
Nuggets	nugg	0.06%	4	Fresh
Drumettes	drumt	0.5%	6	Fresh
Thighs	thigh	7.7%	39	Fresh
Fresh chicken remaining	ast	5%	85	Fresh

Source: AC Nielsen© 2003.

Due to the small size of some categories in the fresh products they were combined with other larger product groups. For instance drumettes + winglettes were put in the wing group and fresh chicken halves and chicken quarters were placed in the assorted group. It should be noted that mechanically separated meat for products such as hot dogs and deli meat are not included in the scanner data.

In order for chicken to be aggregated together the assumption has to be made that all the prices for the individual parts move together in the same proportion. This assumption may be too strong considering the demand profile for chicken has changed dramatically in the last 30years. In 1976 people only ate approximately16kg. of chicken per year, today they eat double that and much of the increased demand has come from further processed products which add value by offering consumers convenience in meal preparation. Retail stores also sell more individual parts so that consumers can choose from a range of differentiated products and focus on only one part of the chicken. The price differences between higher demanded white meat and lower demanded dark meat parts can be significant and price fluctuations do not always move in the same direction or proportion, in fact white meat prices have been going up while dark meat prices have gone down.

In this study once the consumer has decided to purchase chicken at the grocery store there are 23 different types of products. This model assumes that fresh and frozen chicken are substitutes. Another possibility could involve recognizing a distinction between the fresh and the frozen products at the store. Once the decision to purchase chicken is made the consumer chooses between weakly separable groups of fresh and frozen product.

The Complete AIDS Model

The general structure of the 2-stage AIDS models share equation is:

$$\omega_i = \alpha_i + \Sigma_j \gamma_{ij} \ln(p_j) + \Sigma_k q_{ik} SD + J_i Qt(-1) + K_i safety + F_i BSE + B_i TEXP + X_i Time + \beta_i \ln(TEXP/P)$$

where ω_i = expenditure share on the i^{th} commodity
p_j = are commodity prices
SD= seasonal quarterly dummy variables
Qt(-1) = lagged quantity
Safety = food safety index
BSE = BSE dummy variable
TEXP = total expenditure
TIME = time

and

$$\ln(P) = \alpha_0 + \Sigma_j \alpha_i \ln(p_i) + \tfrac{1}{2} \Sigma_i \Sigma_j \gamma_{ij} \ln(p_i)\ln(p_j)$$

is the logarithmic price index.

The model is linear except for the price index which is often hard to estimate econometrically, the price index will be approximated with the Stone Index $\ln(P) = \Sigma\omega_k \ln p_k$ to avoid the simultaneity problems. The model is estimated with an iterative seemingly unrelated regression estimator with the last share equation dropped because of the adding up restriction.

Since the data is time series some potentially serious problems may exist. According to Green (2003) times series data is often autocorrelated so that the variation around the regression function is related from one period to another. Therefore, the model is estimated with autocorrelation corrections built in to avoid this problem. The model is estimated using SUR and maximum likelihood procedures. The program used for conducting the estimation is TSP version 4.5.

The data used for estimation of the AIDS model is the AC Nielsen © weekly scanner data that was provided for the Canadian retail chicken market. The data on chicken parts retail price, quantity, and value were given for many individual fresh and frozen products. The dataset for the model is from November 11, 2000 to November 1, 2003 for a total of 156 weeks. All of the products for the frozen subgroup were branded but in the fresh subgroup both branded and generic product are included. The individual product list illustrates the sheer volume of products, 411 fresh and 311 frozen items of various brands, and package sizes were aggregated to form 11 and 12 commodity groups respectfully (see Table 14). Since the scanner data is national in scope regional differences in regional demand cannot be discovered which is a potential problem since some of the individual items may not be sold in all regions of the country. Figure 5 illustrates that price differences exist for the same product in different regions of the country. However as compared to aggregate disappearance data which contains no product disaggregation, scanner data provides greater insight into some of the more intricate aspects of the demand profile at the retail level.

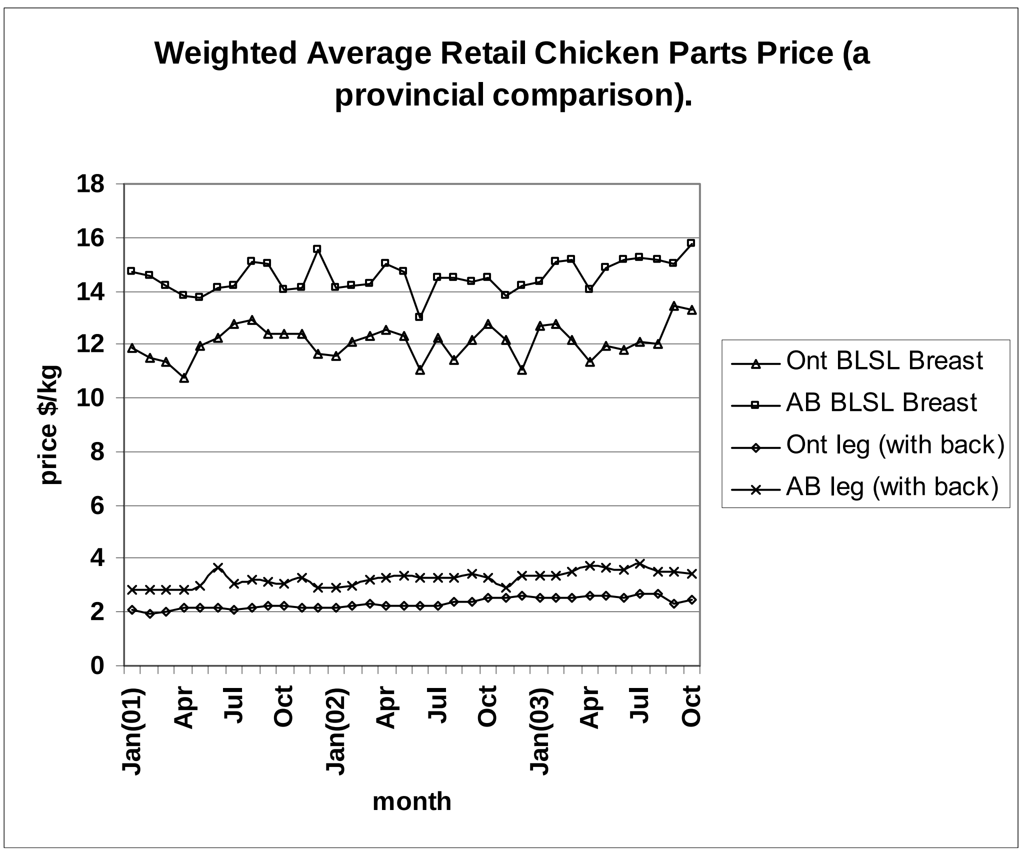
Table 14: Average Retail Price for Twenty Three Commodity Groups Estimated in the AIDS Model.

Product	Product Number	Fresh/Frozen	Retail Price $/kg
Premium Priced Breaded Formed Chicken (PBFC)	1	Frozen	5.57
Value Priced Breaded Formed Chicken (VBFC)	2	Frozen	4.79
Breaded Natural Chicken (BNC)	3	Frozen	12.20
Flavored Chicken Breasts (FCB)	4	Frozen	12.28
Un-flavored Chicken Breasts (UFCB)	5	Frozen	10.34
Chicken Wings (WNGS)	6	Frozen	10.93
Stuffed Chicken (SC)	7	Frozen	15.72
Un-breaded Chicken Burgers (BUGU)	8	Frozen	5.82
Breaded Chicken Burgers (BUGB)	9	Frozen	8.34
Chicken Parts (PART)	10	Frozen	10.06
All other Frozen Chicken (MIX)	11	Frozen	7.69

Whole (whole)	12	Fresh	5.09
Breasts (brst)	13	Fresh	11.06
Drumsticks (drum)	14	Fresh	4.28
Wings (wing)	15	Fresh	6.50
Burger (burg)	16	Fresh	5.43
Legs (legs)	17	Fresh	2.79
Winglettes (wingt)	18	Fresh	5.35
Kabobs (kabob)	19	Fresh	12.19
Nuggets (nugg)	20	Fresh	7.20
Drumettes (drumt)	21	Fresh	8.48
Thighs (thigh)	22	Fresh	5.71
Assorted Fresh (ast)	23	Fresh	5.57

Source: ACNielsen© 2003

Figure 5: Comparison of Chicken Product Retail Price: Alberta and Ontario

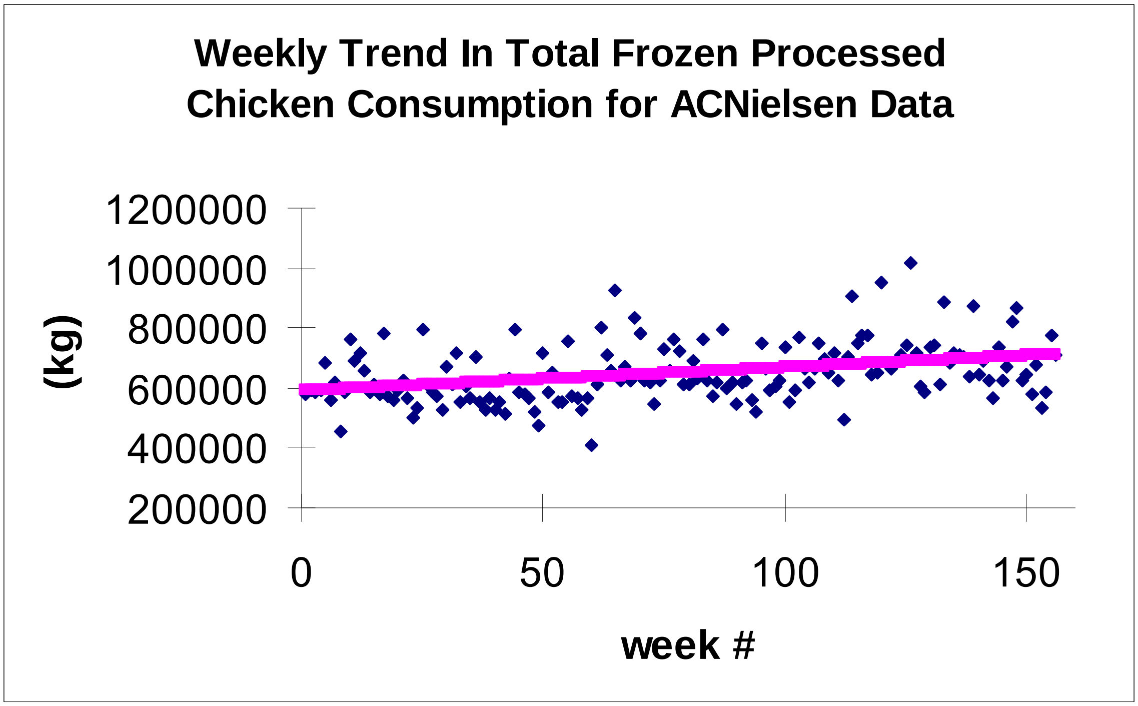


Source: Agriculture Canada Poultry Market Review 2003

General Consumption Trends for Fresh and Frozen Chicken

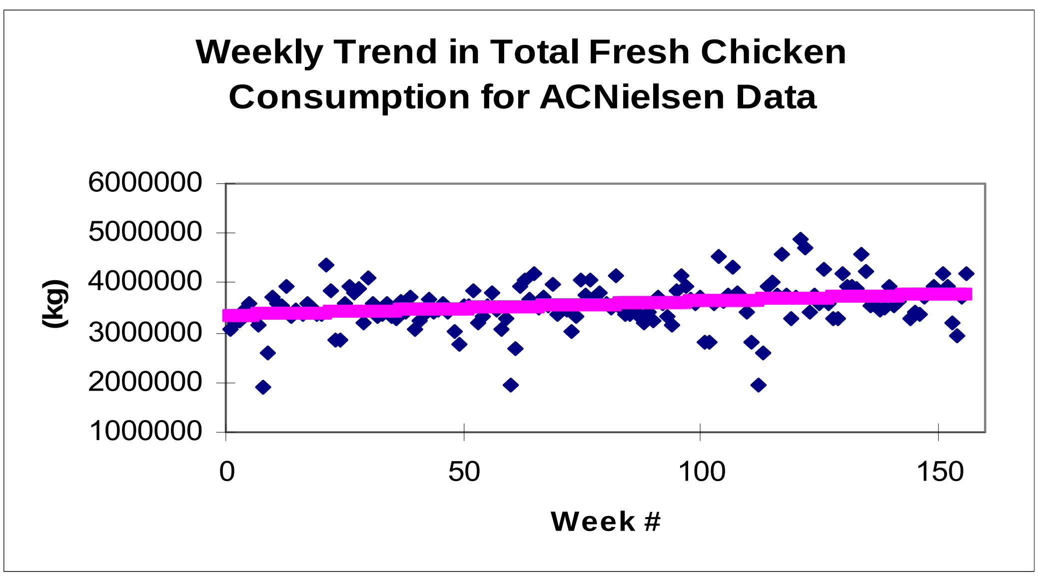
It is interesting to examine some of the basic trends and descriptive statistics for each of the twenty three product groups to see if any predominant trends or predictions can be made about the results. From the aggregate per capita disappearance data, presented earlier, it is evident that total chicken consumption is increasing but this may be due to food service taking an increasing share of the meat dollar, hence it is of interest to examine retail consumption trends for fresh and frozen chicken purchased through grocery stores. Examining Figure 6 the weekly trend in frozen processed chicken consumption; a significant upward trend in total amount consumed even over the short time period of the data can be seen. From the trend line it can be seen how in every week consumption of frozen chicken has been increasing by about 784 kg. Since much of the new product development is concentrated in this area the upward trend is not surprising but still relatively small compared to the upward trend in fresh chicken consumption as illustrated in Figure 7. The level of fresh chicken consumption and the rate of growth is much higher than frozen chicken, fresh consumption increases in total by approximately 2843 kg. each week.

Figure 6: Frozen Chicken Product Trend



Source: ACNielsen© 2003

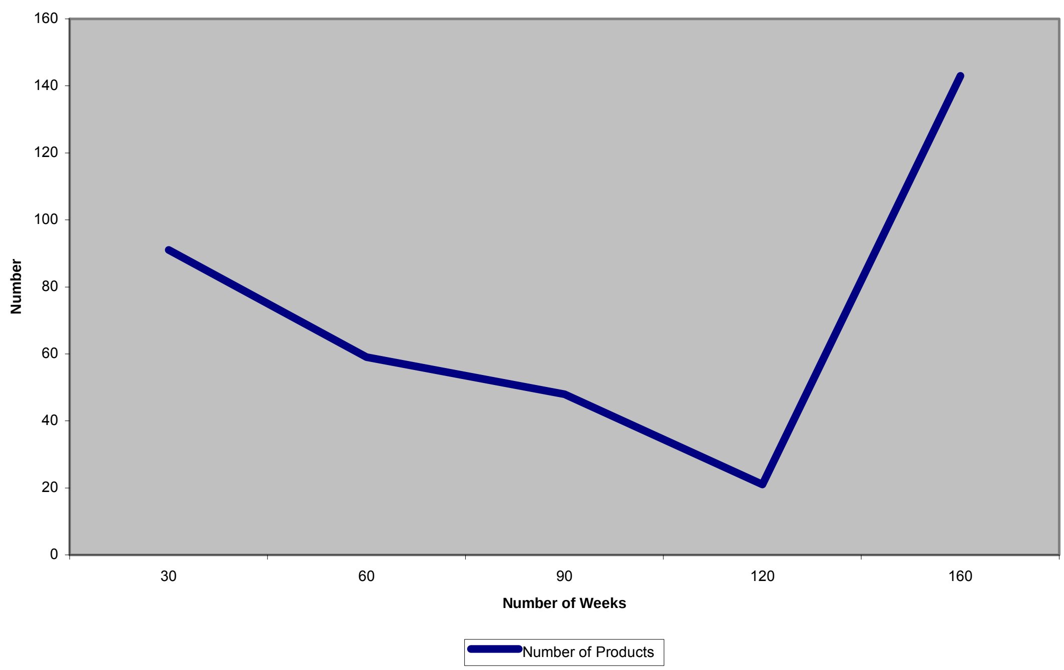
Figure 7: Fresh Chicken Product Trend



Source: ACNielsen© 2003

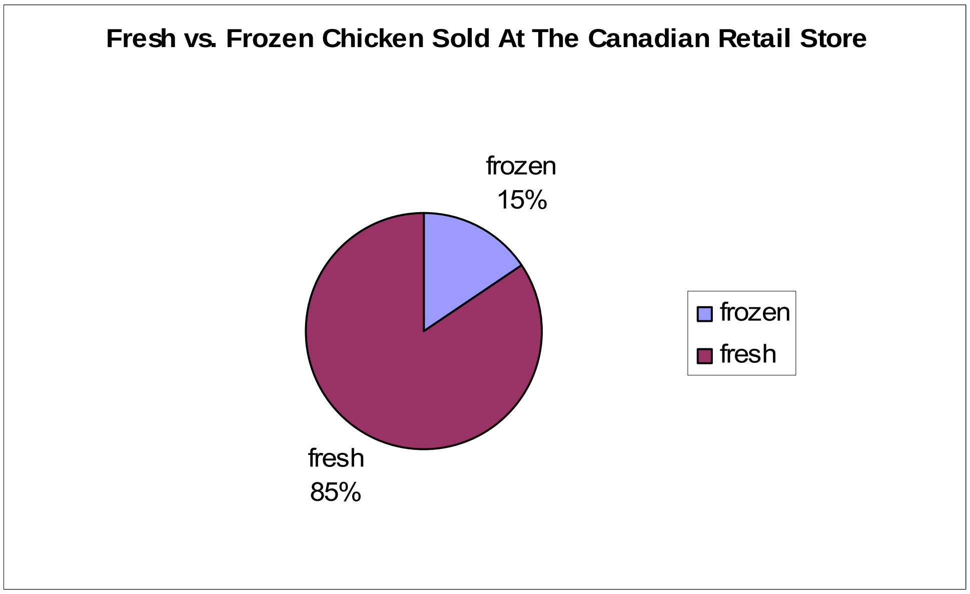
New product introductions over the period of the sample (2000-2003) are of interest as well. There are a large number of new chicken processed products introduced into the market that remain in the market for less than 30 weeks. This represents a relatively large share of new product introductions that are not successful reflecting high transactions costs. In Figure 8 the longevity of the 160 new chicken processed products introduced into the market place is highlighted. 91 of these products remain in the market for less than 30 weeks while 140 remain in the market continually after their introduction.

Figure 8: Chicken Branded Products Introduced 2000 to 2003



In terms of quantity, fresh chicken comprises 85% of the retail market and frozen chicken only accounts for 15% as illustrated by Figure 9. Frozen chicken is a diverse and dynamic area where many of the products are focused on convenience and include microwavable dinners like “cordon bleu”, “kiev”, and other marinated and breaded products. Very little frozen chicken is in a raw unprocessed form such as frozen utility birds. Another important observation is that except for wings, burgers and perhaps some specific products in the MIX category almost all frozen chicken is white meat.

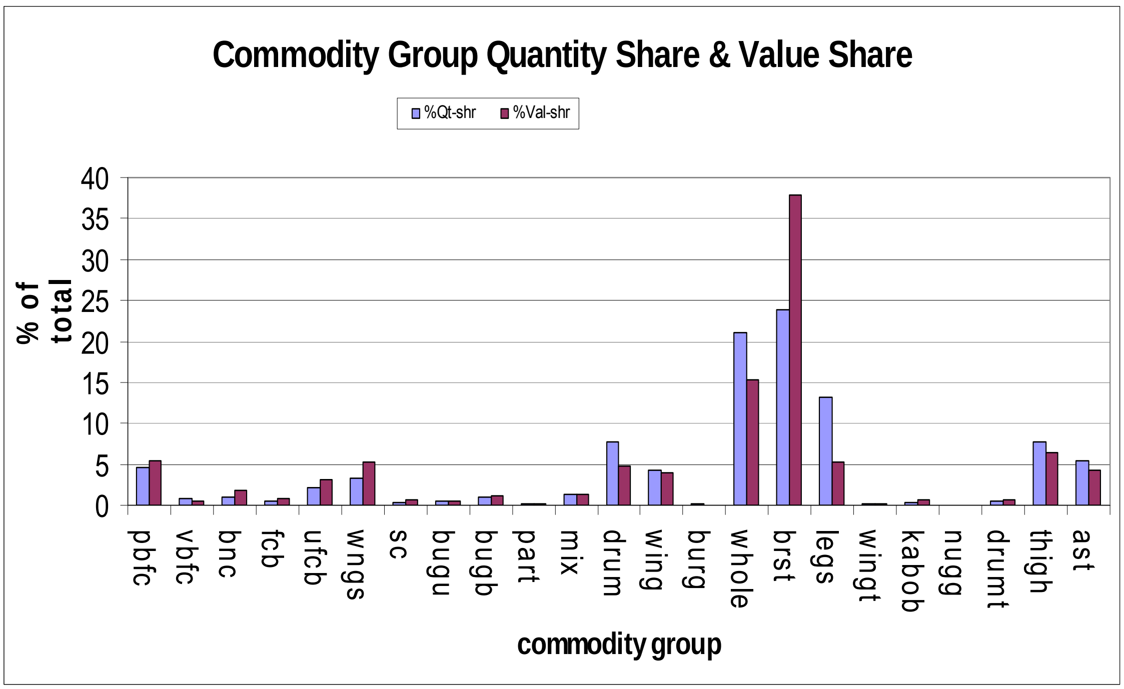
Figure 9: Fresh and Frozen Chicken Market Share



Source: ACNielsen© 2003

Data presented in Figure 10 illustrates the breakdown of the 23 different product categories presented in this study. Except for very small categories on the fresh side like winglettes, kabobs, nuggets, and burgers almost all of the commodity groups on the frozen side are smaller than any commodity group on the fresh side. Frozen wings and premium priced breaded formed chicken are the two largest groups on the frozen side and breasts are the largest category on the fresh side illustrating white meats' high demand. Surprisingly whole birds still make up the second largest commodity group at 21% of total retail chicken. On the graph value share was placed right beside quantity share to see if the two are proportional to one another; generally they are not. Only for certain products like frozen burgers, parts, and mix do they exist in equal proportion. For every commodity group except value priced breaded formed chicken the value shares are greater than the quantity shares. This may be because many of the frozen products are white meat which is the higher valued meat and it may reflect the fact that people are paying for additional convenience. On the other hand, most fresh chicken groups except for breast meat, kabobs, and winglettes have quantity share exceeding value share. Major dark meat categories like legs, thighs, and drums, also exhibit this trend.

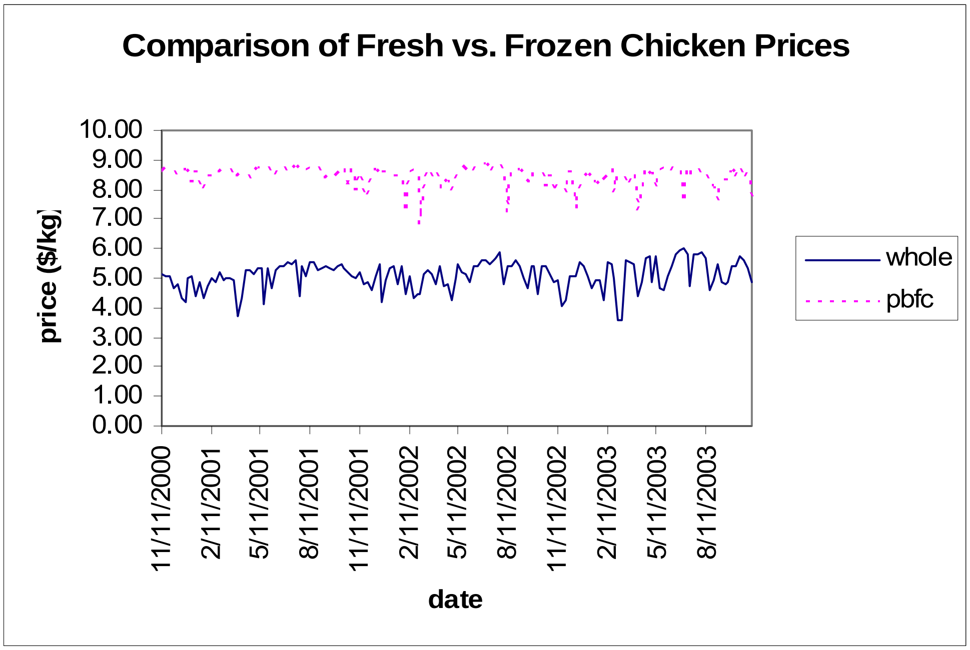
Figure 10: Share of Chicken Sales by Product Type



Source: ACNielsen© 2003

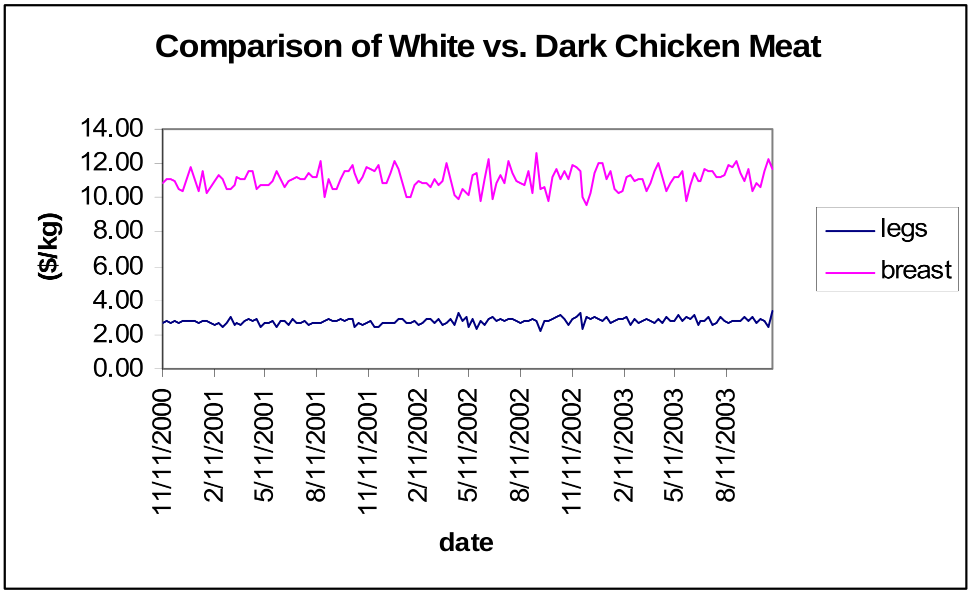
The average price (unit values) for the twenty three different chicken products vary greatly, where frozen further processed items are higher priced as compared to fresh (see Table 14). The price for dark meat is lower then the price of breast meat indicating that the demand profile for these two meats and their associated products could differ substantially. Figures 11 and 12 highlight some of the dramatic differences in major groups, the differences between white and dark meat products and fresh and frozen product.

Figure 11: Comparison of Fresh and Processed Chicken Prices



Source: ACNielsen© 2003

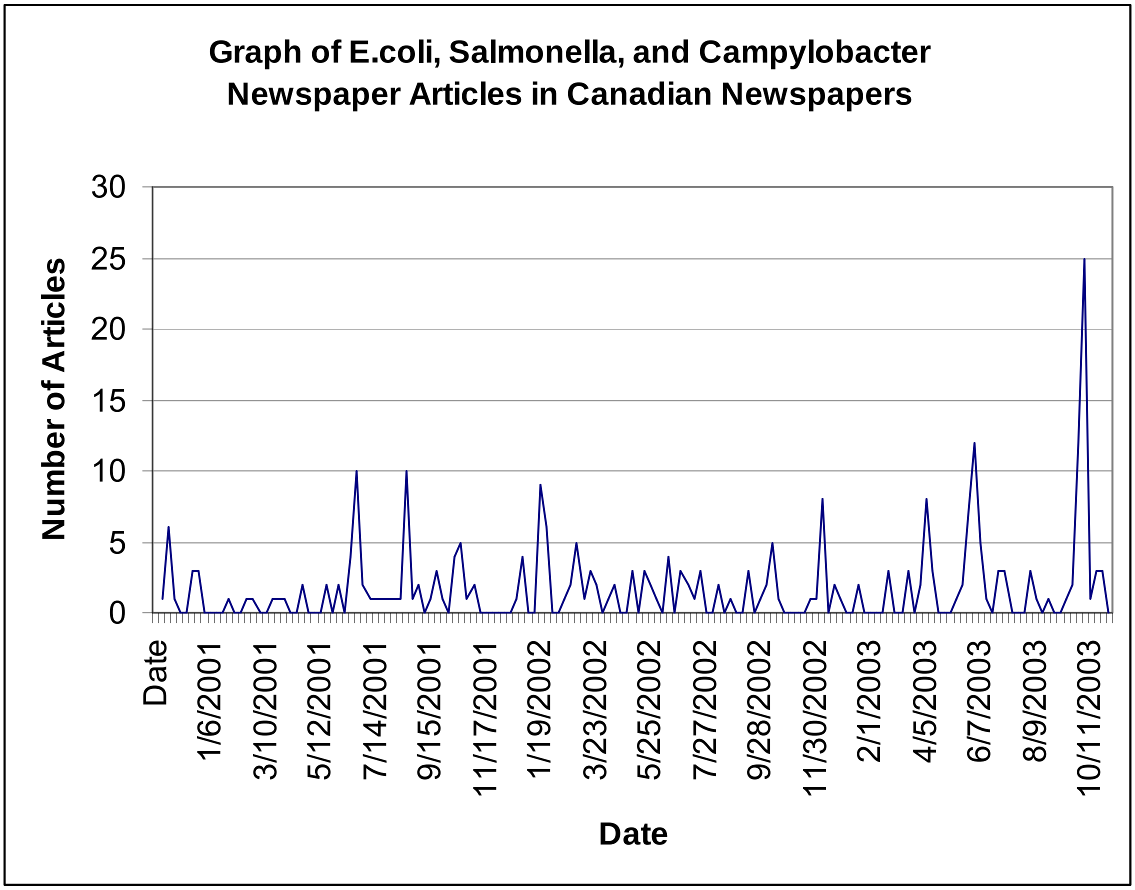
Figure 12: Comparison of White versus Dark Meat Chicken Prices



Source: ACNielsen© 2003

In the model to be estimated identified above, food safety was hypothesized to be a factor affecting both the total expenditure on chicken and the individual expenditure shares for chicken by product type. The data for a food safety index was generated from print media database searches over the sample period of the data presented. The databases were searched for articles linking chicken consumption and food safety considerations such as E. Coli, Salmonella and Camplyobacter. As can be seen from Figure 13 coverage of these issues in major Canadian newspapers is highly variable across the sample period.

Figure 13: Print Media Coverage of Major Food Safety Issues Related to Chicken



Source: Factiva & Canadian Newsstand 2004

Empirical Results

Estimation of Parameter Results for the AIDS Model

The model was estimated across the two stages simultaneously. At the first stage, the price of beef and the food safety index were not significant at the 10% confidence level or less, suggesting little relationship between aggregate chicken expenditure and these variables. The price of pork coefficient is significant and negative implying a complementary relationship since if the price of pork increases the consumption of chicken will decrease. The food safety index was not significant at the 10% confidence level at the first stage so as the incidence of E.coli, Salmonella and Campylobacter reporting increases the level of chicken consumption does not necessarily go down implying that people generally do not respond to these food safety concerns at the macro level. The lagged total expenditure coefficient is positive, significant and between zero and one indicating habit persistence, if consumers purchased chicken last week they are likely to purchase it this week. All three of the seasonal dummy variables are significant and positive implying that the least amount of chicken is consumed in the fall and more is consumed in the other seasons relative to the fall. Both Thanksgiving and Christmas occur in the fall for the dataset and on both occasions big meals tend to be served with turkey being the bird of choice. In the time of the year where the most turkey is consumed less chicken might be purchased. The BSE dummy variable is significant at the first stage and has a positive sign indicating the weeks after the BSE incident (May 2003) spurred consumers to purchase more chicken which on the surface appears to be a logical result. Personal disposable income is also statistically significant and positive implying that as a persons' income rises they will purchase more chicken.[2]

At the second stage of the model, some of the significant time trend coefficients were positive which is expected since chicken consumption in general is increasing. However, others like breaded natural chicken, frozen parts, fresh drumettes, burger and assorted fresh chicken had a significantly negative time trend. This implies that while overall chicken consumption is on the increase , at the individual product level the trends are not uniformly positive.

The food safety index coefficients at the second stage did not have a significant effect on any of the individual products. Since no specific product recalls occurred over the time period of the data for chicken, many of the included articles focused on warning

[2] Statistical Significance or significant, refers to the 10% level unless stated otherwise in the text.

people to cook the meat properly. The non-threatening nature of the articles is probably the cause of the low effect at the second stage. E.coli, Salmonella, and Campylobacter can be killed easily with proper preparation techniques, potentially explaining why the impact was weak.

Seasonal trends still exist in the individual chicken product consumption. Products that had a consistently significant seasonal trend in all three quarters include VBFC, FCB, PARTS, whole, brst, and assorted fresh. FCB is a frozen white meat product where more is consumed in the winter relative to the fall. Frozen PARTS experiences its highest consumption in the fall. On the fresh sub-group side, whole birds are still mostly consumed in the fall quarter. Whole birds come in two types, fryers and roasters where roasters are larger. Around Thanksgiving and Christmas more roasters are sold possibly because they substitute well for a small turkey.

Frozen wings are also seasonal with more sold in the fall. This is not surprising considering wings are a popular food served at informal gatherings and as the weather gets cooler outside less barbequing occurs. Fresh breast meat is consumed more in the spring than in any other season. Frozen burgers both breaded and un-breaded are consumed significantly more in the spring and summer than in the fall. Fresh burgers are consumed more in the spring than in any other season. Frozen burgers both breaded and un-breaded are consumed significantly more in the spring and summer than the winter or fall due again to the increase in outdoor cooking activity. BNC shows an opposite trend to that of burgers where more is consumed in the winter than the spring or summer, this trend holds for PBFC as well.

The BSE dummy variable had some results, first that the outbreak has not caused consumers to purchase more chicken across the board for every chicken product. Some products had positive coefficients while others had negative. On an individual product basis PBFC and BNC went down and so did wings on both the frozen and fresh side. Products that experienced gain include fresh burgers and nuggets and frozen un-breaded burgers . In the aftermath of the outbreak consumers appear to have been searching for products that can substitute well with beef. However, the time of the discovery also needs to be taken into account since mid May is the typical start of the Canadian BBQ season so consumers could have been drawn to these particular products for that reason alone. However, BBQ items were not the only ones to experience gain, fresh nuggets along with frozen FCB consumption were also higher after BSE. FCB is a commodity group that consists of highly marinated and processed breast meat, a product not suitable for the BBQ but would substitute nicely for a steak on the dinner plate. Recall that the chicken purchased at the retail store increased after BSE as indicated in the first stage of the demand system. Anecdotal evidence suggests that Canada was the only country where a BSE outbreak actually encouraged more beef consumption. There also may be two classes of consumers in the marketplace that responded differently to the BSE outbreak. One group may have responded by purchasing more beef from unconventional sources and the other group may have responded by purchasing more chicken from the retail store specifically the products that substitute well with beef. Many of the products with increased demand are higher end white meat items. It may be that consumers at the retail store turned away from beef and more traditional breaded chicken products and wings for higher processed white meat. Before making any strong conclusions scanner data would need to be studied for both chicken and beef over a much longer period of time.

Table 15 presents the own and cross price effects for each of the twenty three products. Most of the own price effects are significant except for, legs, kabobs, nuggets, drumettes, thighs, and assorted fresh chicken. The fresh products that did not have significant own price effects are either very small in terms of consumption level or dark meat. Many of the cross price effects are significant as well, but the coefficients can either be positive or negative in sign. If the cross price effect is positive that implies the goods may be substitutes and if the effect is negative the goods may be complements.

Table 15 Own and Cross Price Chicken Product Elasticities Across Both Stages[3].

	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11
p1	-2.86874***	0.239049	0.255253**	0.412342**	0.063058	0.100998	-0.716556**	0.575023**	-0.600091***	-0.429377	0.477307***
p2	-0.229889***	-0.070087	-0.212493***	0.015766	-0.137902***	0.294459***	-0.117078	-0.4305***	0.014648	0.077767	-0.012656
p3	-0.021309	-0.507363***	-3.67913***	0.110247	0.011802	0.1485***	0.221117	0.059092	0.691058***	0.230588	0.174437**
p4	-0.123359***	0.018054	0.010381	-2.01616***	-0.064385	0.320625***	-0.048935	0.052848	0.084507	-4.22E-03	-8.02E-03
p5	-0.027292	-0.166372	0.085781	0.073483	-5.00045***	0.561751***	-0.054394	0.054116	0.044516	0.317599	-0.333238
p6	-0.03609	-0.365674*	0.120086	0.713122***	0.80649***	-2.17425***	-0.268617	0.552811**	0.175371	0.582271	0.141403
p7	-0.306851***	-0.143151	0.042993	-0.034928	-0.105507*	0.22791***	-1.59967***	0.170807	0.476808***	-0.137383	0.059757
p8	-0.250094***	-0.367989***	-0.045331	0.026777	-0.119165*	0.451984***	0.106749	-0.159946	0.018527	0.106121	-0.037967
p9	-0.277077***	0.041503	0.415835***	0.123995*	-0.052172	0.188408***	0.792847***	0.073034	-2.27836***	0.26702	1.74E-03
p10	-1.0261***	0.011486	-0.154539***	0.0186	-0.387278*	1.73537***	-0.027223	0.039375	0.024105	-3.89284***	0.027951
p11	-0.025034	-0.018703	0.098838**	7.78E-04	-0.207748**	0.162075**	0.122599	-0.079563	2.70E-03	0.235095*	-1.9027***
p12	0.123759*	0.017513	0.155945**	0.254182*	0.732363***	-0.208684*	-0.221416	-0.028015	0.449424***	-0.127059	0.373348*
p13	0.354597***	-0.020651	0.188659	0.193651	1.72092***	0.67548***	0.553304*	-0.372799	0.321616*	0.464967	0.332331
p14	0.089134*	-0.253421	-0.034722	-2.32E-03	-0.175705	0.294049***	-0.164884	-0.343172	-0.117943	0.582236	-0.121269
p15	-0.068107	-0.061376	-0.055806	-0.115409	0.217915**	0.135891*	0.021796	-0.202023	-0.201004*	0.116814	-0.091183
p16	-1.79204***	3.63E-03	-0.288619***	0.038468***	-0.701911*	3.13974***	0.016359	0.051791**	-8.18E-04	2.39E-03	0.013281
p17	-0.113033	0.120346	-0.014109	0.030678	0.091532	9.40E-03	0.024152	-0.114814	-0.120876	0.015715	0.405918*
p18	-0.94352***	-0.032793	-0.152843***	0.025062***	-0.365611*	1.59929***	-5.14E-03	3.92E-03	0.012374	0.161088**	-4.76E-03
p19	-0.080675	9.24E-03	3.26E-03	-0.080913	-0.041065	0.357616***	0.412091**	-0.184715	0.021639	0.395973*	-0.183558*
p20	-2.00649***	0.040799**	-0.328716***	0.045996***	-0.780635*	3.52067***	-0.029026**	0.059712***	6.91E-03	-0.025467	0.02617
p21	-0.26414***	0.180142	-0.028779	0.082862***	-0.043701	0.316261***	0.060716	0.079687	0.106103	0.221744	-0.022072
p22	0.115299	0.091885	0.290309**	-0.143294	-0.293439	0.280832**	-0.406229*	-0.655136***	5.37E-03	-0.592286	-0.144189
p23	0.088067	0.080443	0.148176*	-0.288535*	-0.073168	-0.263695***	0.244136	0.724164*	-0.266181**	-0.04662	-0.16979

[3] Products 1 through 23 are identified in Table 14.

Table 15 cont. Own and Cross Price Chicken Elasticities Across Both Stages.

	p12	p13	p14	p15	p16	p17	p18	p19	p20	p21	p22	p23
p1	-0.399618***	0.51163***	0.152643***	0.038233	0.266626	-0.105586	0.017164	1.41718***	0.042969	-0.210611	0.118967*	0.192534*
p2	-3.15875***	6.89534***	-0.135907***	0.068506***	0.08925	-0.202735***	-0.111181	0.022827	0.451922***	0.172703	-0.081699	-0.028399
p3	-1.08301***	2.01076***	-0.058758	4.42E-03	0.17052	-0.09297***	0.104903	0.166555	-0.011639	0.070609	0.030084	0.041971
p4	-2.10092***	4.38644***	-0.088019***	0.012348	4.12E-03	-0.156876***	0.067918	-0.100877	0.026068	0.120808***	-0.100995***	-0.099258***
p5	-0.541049***	1.16078***	-0.132549	0.21601***	-0.11232	1.60E-03	0.176294*	0.330103	-2.69E-03	0.306788***	-0.172379*	-0.047273
p6	-0.608558***	0.517359***	0.22113**	0.124676	0.189868	-0.115789	0.669413***	0.579995	-0.34697*	0.222267	0.133184	-0.407588***
p7	-2.59528***	5.53009***	-0.118189***	0.061011	0.21108*	-0.181082***	5.67E-03	0.473554**	-0.309338***	0.07985	-0.127959***	6.32E-04
p8	-3.76324***	8.31806***	-0.157107***	0.069424***	0.208575	-0.263376***	-0.018491	-0.131693	0.267812**	0.062967	-0.149786**	0.034693
p9	-1.59616***	3.23941***	-0.101711***	-0.032017	-6.27E-03	-0.157788***	0.166833	0.068401	0.109324	0.218004*	-0.070924*	-0.107142***
p10	-14.4267***	33.8254***	-0.330917***	0.481071***	8.86E-03	-0.840737***	0.152699**	0.109435***	-0.047483	0.067429	-0.231467	-0.048615
p11	-1.39903***	2.76084***	-0.103554**	-0.010941	-0.125864*	-0.020266	-0.080503	-0.356853*	0.050668	-0.020707	-0.100253**	-0.088892*
p12	-1.77531***	0.023204	0.03603	-0.110381*	-0.142047	-0.029568	-0.292728***	0.38795	0.024702	-0.304036***	-0.026556	0.117322
p13	-0.406344***	-1.47563***	-0.136972	0.164141	-0.533211***	0.065712	0.023651	0.211365	-0.031245	0.042662	-0.248447*	0.035598
p14	-0.497094***	0.539644***	-1.50574***	0.066409	0.026625	-0.320122***	0.543742**	-0.181799	0.052233	0.541981***	0.106766	-0.021665
p15	-0.635986***	0.718737***	-2.67E-03	-1.36324***	-0.098811	-1.24E-03	0.066046	-0.287981	-0.450893***	-0.041457	0.027554	-0.035164
p16	-25.8943***	61.2223***	-0.590593***	0.884193***	-0.548443***	-1.48339***	0.221427***	0.087537***	0.07323**	0.028395	-0.35541	-0.056993
p17	-0.470002***	0.49307***	-0.320619***	0.114108	-0.26684**	-0.939589***	2.31E-03	-0.304593	-0.052976	-0.086448	-0.366528***	-0.087271
p18	-13.3209***	31.1701***	-0.309428***	0.437775***	0.427793***	-0.781656***	-0.59884***	0.037231*	0.039054	-0.023934	-0.220376	-0.050588
p19	-2.84607***	6.15917***	-0.13179***	0.012437	0.240325**	-0.243147***	0.039814	-0.860996***	-0.209516**	-0.024095	-0.109154*	-0.205645***
p20	-29.0234***	68.7037***	-0.656502***	0.991437***	0.066179**	-1.65427***	0.021189	0.051103**	-1.03473***	0.052815**	-0.388826	-0.055845
p21	-2.8689***	6.14936***	-0.034234	0.053415**	-0.174031	-0.215245***	-0.217496	-0.020645	-7.23E-03	-0.987709***	-0.109373**	-0.048814*
p22	-0.437521***	0.302617***	0.16716*	0.149163**	-0.095485	-0.451554***	-0.518742**	-0.147112	0.146549	-0.168622	-1.06347***	-5.41E-03
p23	-0.518195***	0.63436***	-0.042611	2.64E-03	-0.014368	-0.124775	-0.058001	-1.09447***	0.196288*	-0.025424	-0.039834	-0.974472***

Table 16 Expenditure Elasticities Across Both Stages.

Across Both Stages			
Parameter	Estimate	S.E.	Significance
YB1	0.645366	0.103619	***
YB2	0.722165	0.116049	***
YB3	0.759932	0.107908	***
YB4	0.756214	0.146837	***
YB5	0.60686	0.331611	*
YB6	0.304857	0.133523	**
YB7	0.831498	0.170863	***
YB8	0.72569	0.143654	***
YB9	0.745332	0.127134	***
YB10	0.724425	0.176534	***
YB11	0.880158	0.193023	***
YB12	1.05732	0.110062	***
YB13	0.74692	0.098697	***
YB14	0.91549	0.112173	***
YB15	0.699078	0.103421	***
YB16	0.583413	0.134578	***
YB17	0.916724	0.128508	***
YB18	0.73351	0.11959	***
YB19	0.804359	0.3112	**
YB20	0.741722	0.117499	***
YB21	0.506353	0.12394	***
YB22	0.918779	0.114185	***
YB23	0.789556	0.110176	***

Table 17 Own and Cross Substitution Elasticities

	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11
s1	-49.5821***	5.48038*	6.67727***	8.17094***	3.32308	2.08374	-11.9916**	10.6351**	-9.81403***	-6.35431	9.7622***
s2		-10.5321	-27.5772***	3.70951	-4.21896	-5.86869	-18.8538	-76.3075***	5.10366	15.4835	-6.08E-03
s3			-206.369***	7.13743*	5.16953*	4.34436*	13.8856	3.62935	40.8402***	14.6428	11.3822***
s4				-232.964***	3.13377	14.3097***	-4.04766	6.45928	11.8107*	1.08773	0.983147
s5					-159.845***	17.6469***	-0.61978	1.96381	2.70648	11.8201	-9.63026
s6						-41.3942***	-4.0696	10.7391**	4.48547	12.6132	3.78056
s7							-228.543***	24.9078	70.8873***	-18.1705	10.6871
s8								-33.9224	6.70627	24.3125	-5.72842
s9									-197.721***	24.9242	1.85974
s10										-3271.26***	19.3369*
s11											-142.489***
s12											
s13											
s14											
s15											
s16											
s17											
s18											
s19											
s20											
s21											
s22											
s23											

Table 17 Own and Cross Substitution Elasticities Cont.

	s12	s13	s14	s15	s16	s17	s18	s19	s20	s21	s22	s23
s1	2.61461***	2.50986***	4.83731***	1.66513	5.0653	0.615931	-0.063838	25.6019***	1.8044	-3.7565	4.29351***	5.20277***
s2	1.18217*	0.993654**	-4.20538	-0.400391	16.1631	3.40514	-20.0359	3.31685	81.4828***	30.5933	2.55984	3.01231
s3	2.81807***	2.22646***	1.35833	0.774943	9.93903	1.77462	5.6349	9.34463	0.37841	4.21305	6.54638***	5.57165***
s4	2.24607**	1.06143	0.626374	-2.23225	0.737493	1.24232	7.58766	-11.9788	4.09637	14.1814***	-1.6159	-5.99585*
s5	6.53852***	6.15366***	-1.40472	8.04535***	-3.44019	3.93627	5.37487	10.566	0.941289	10.1175***	-2.55155	0.701656
s6	-1.04753	2.00086***	6.33754***	3.36478*	3.8408	0.398384	12.4345***	10.8809	-5.61785	4.33838	4.73151**	-6.07058***
s7	-0.456753	2.43143***	-2.3946	1.66222	30.6652*	1.52648	0.538985	67.7413**	-43.4545***	11.5629	-5.34883	6.75021
s8	-0.069074	-0.884012	-7.06972	-4.95491	44.7568	-2.01299	-4.19013	-29.2301	58.1977**	13.0148	-10.1719***	16.9492*
s9	3.95476***	1.81665***	-1.33877	-3.92001	-0.304473	-1.15979	14.2932	5.81839	10.6287	19.2941*	1.18135	-4.99783
s10	0.624093	2.67988***	13.7505	4.44697	7.91537	1.76778	127.544**	64.9223*	-38.4904	37.0247	-7.86331	0.394931
s11	3.38601**	1.76961**	-1.46187	-1.17723	-9.29409*	8.75317**	-6.42001	-27.1752*	4.88815	-1.35956	-1.23314	-2.81597
s12	-8.20291***	1.23785***	1.70749***	0.021741	-0.731376	1.53771**	-2.3091***	2.27252	1.1775*	-1.96651***	1.25202**	2.02347***
s13		-2.63249***	0.935409***	1.06672***	-1.20839**	1.69101***	-0.330998	0.265758	0.93106**	0.120139	0.547716	1.20047***
s14			-29.5375***	2.39828**	0.769967	-3.97266***	11.0924**	-4.04466	2.12435	11.5218***	4.55721***	1.34639
s15				-33.6333***	-2.30107	3.13574**	1.30987	-7.51757	-10.4377***	-0.944361	3.28488***	1.07419
s16					-830.953***	-4.84189**	332.308***	38.694**	112.796**	-27.4988	-1.29867	-0.123169
s17						-15.1824***	-0.332184	-5.98247	0.019376	-1.55166	-4.76606***	0.069679
s18							-465.275***	6.09492	31.7057	-34.9861	-8.55105**	-1.7151
s19								-138.193***	-32.3953**	-3.86465	-2.54874	-25.5576***
s20									-1757.14***	-0.060968	3.32879	5.57103**
s21										-157.672***	-2.58569	-0.487903
s22											-14.7798***	1.51566
s23												-20.6917***

The own and cross price elasticities taken across both stages of the model tend to be highly elastic. This is true for both the fresh products and the frozen ones. Many of the cross price elasticities are significant . For example, looking at the fresh breast meat commodity only at the second stage PBFC, BNC, UFCB, WNGS, SC, PART are substitutes and BUGU, burg, wingt, and drumt are complements. Isolating breast meat as a single category provides some illumination on the degree of substitutability. There are a greater number of statistically significant interactions between fresh breast meat and other commodity groups than between any other individual product and the rest. It appears that except for whole birds where the relationship is not statistically significant all of the other commodity groups are substitutes for fresh breast meat.

The expenditure elasticity measures by what percentage quantity demanded changes for a 1% increase in expenditure on a particular commodity group. Table 16 gives the expenditure elasticities across both stages of the estimated model. All of the expenditure elasticities across both stages have the expected positive sign except for fresh winglettes. If the expenditure elasticity is >1 then the goods in question are luxuries and if it is <1 then the good is a necessity. Most of the expenditure elasticities are significant at the 10% level or better indicating that the amount people have to spend on chicken influences how much they purchase. Since many of the frozen items are white meat and further processed they were expected to be luxuries with elasticities >1. PBFC, BNC, UFCB, PART, whole, drums, legs, thigh have expenditure elasticities >1. . Much of the product development has occurred in the frozen and further processed subgroups. Characterized by high turnover frozen chicken contains many experimental goods and companies try to see which products will catch on with consumers, examples would include products like “dinosaur shaped breaded chicken.” Therefore, since many of the items are new consumers perhaps have not tried them or even know that they exist so the expenditure elasticities are smaller, not reflecting luxury goods. Whole birds also appear to be a luxury good with an expenditure elasticity of 1.84 implying that if a consumers expenditure increases by 1%, expenditure on whole birds goes up by more than 1%. Breast meat is expenditure inelastic so many consumers may already view it as a necessity perhaps because of health aspects.

Substitution elasticities are also calculated for the commodity groups. Table 17 gives the substitution elasticities. The substitution elasticity measures the percent change in the ratio of good y to x purchased in response to a percentage change in the price ratio (Binger and Hoffman, 1998). All of the own substitution elasticities are negative as expected. The cross substitution elasticities are also given but to be consistent only breast meat will be examined in detail, all other commodity groups can be analyzed in the same fashion. Most of the elasticities are significant and since none that are significant are negative it indicates people are willing to substitute towards breast meat if the price of other chicken products goes up. This is particularly true for other white meat products. For example if the price of frozen unflavored chicken breast were to increase by 1% consumers would substitute towards fresh breast meat by 6.1%. If the price of dark meat products such as thighs or drums increases people are much less willing to substitute to breast meat. This could be because dark meat is priced much lower compared to white meat and a large price increase would be needed before people would be encouraged to switch. This indicates that the substitutability of the two meat types is not very high. Or there could be different types of consumers in the market with strict preferences for either white or dark meat. People with strong preferences for one of the meat types are not willing to substitute easily. The smaller the substitution elasticity the less opportunity for trade off that exists and the two meats may be more like complements rather than substitutes. Another interesting commodity group is whole birds since it contains both types of meat. Overall the substitution elasticities are greater then one for every significant elasticity. Even for dark meat products like thighs and drums consumers are willing to switch to whole birds if individual product prices increase. With respect to white meat products on the frozen side which are less marinated, they are more substitutable with whole birds probably because they produce an un-marinated and un-seasoned breast just like the whole bird has.

Market Simulation Model

Even though the results just presented can provide a great deal of economic information more can be done with them. The parameters of the estimation can be used to construct market simulation experiments that can assist the industry in developing a marketing strategy by improving the quality of information in the system. A model can be developed that is focused on the domestic market with different chicken products supplied and demanded and includes the farm, processing, and retail sectors. The model can be used to illustrate how the farm supply, producer surplus, processor revenue and the domestic quantities are affected by a change in the pricing strategy for different types of chicken products. The simulation model can be used to discover the dynamic relationships that exist between white and dark meat.

In developing the model and given the conformation of chicken it is necessary to develop some proportional yields for each of the 23 products in the model. The assorted (ast) category serves an important role with respect to live chickens slaughtered. Since the product is not defined the residual between the yields of each of the other 22 products and the total eviscerated weight of chicken can be ascribed to the assorted category. All of the yields of each product are derived from a whole eviscerated chicken. Since many of the frozen products are white meat their proportion is subtracted from the breast meat category and other dark meat products like burgers are derived from either, legs, or the assorted category of fresh dark meat.

The synthetic simulation model contains a wide array of data from 2001 to be able to reproduce a static representation of the market at a particular point in time. Data on retail quantities, retail price, farm supply and live birds, farm marginal cost, and quota value as well as processor supply and export levels are given, providing starting values for the simulation (1). Since the chicken industry is supply managed, in 2001 farmers received a negotiated price for each bird in this case \$1.45/kg live. The farm price is made up of two components; the first is marginal cost which is subject to supply conditions. The other component is the average static quota value which makes up the difference between marginal cost and the regulated farm price, processors pay the regulated farm price. Farm marginal cost and farm supply of live birds were obtained from the CFC (2002). Retail prices come from the A C Nielsen© data. For the sake of the model simulation it is assumed that every bird slaughtered yields 1.53 kg of eviscerated meat (CFC Chicken Data Handbook, 2002).

There are two main market levels illustrated in the model, the first is the processor level and the other is the retail level. Market levels are linked together since Retail Demand equals Processor Supply for a particular product and Processor Demand for Live Birds equals Farm Supply for live birds. Farm supply and processor demand elasticities are taken from Fulton and Tang's (1999) analysis of the Canadian chicken industry to calibrate the processor demand and farm supply equations. Retail prices for individual products are linked to the farm price and to the volume of product flowing for each individual product. The quantity elasticities for each price linkage equation are identified below in Table 18. Chicken burgers, winglettes and nuggets did not have quantity coefficients that were statistically significantly different from zero

Table 18: Retail Price Linkage Equation Quantity Elasticities (t statistics in parentheses)

Product	Quantity Elasticity
Premium breaded formed chicken	-.12 (-8.38)
Value priced breaded formed chicken	-.07 (-2.74)
Frozen breaded natural chicken	-.03 (-1.28)
Frozen flavoured chicken breast	-.19 (-4.83)
Frozen chicken breasts	-.08 (-6.19)
Frozen wings	-.09 (-2.99)
Stuffed Chicken	-.13 (-1.75)
Frozen chicken burgers	0
Frozen breaded chicken burgers	-.05 (-1.99)
Frozen chicken parts	-.04 (-1.86)
All other frozen chicken	-.11 (-3.46)
Fresh whole chicken	-.35 (-12.14)
Fresh chicken breast	-.18 (-4.37)
Drumsticks	-.23 (-6.22)
Chicken wings	-.35 (-5.67)
Chicken burger	-.18 (-4.70)
Chicken legs	-.12 (-3.12)
Chicken winglettes	0
Chicken drumettes	-.03 (-1.98)
Chicken kabobs	-.56 (-7.40)

Chicken nuggets	0
Chicken thighs	-.25 (-7.04)
Assorted chicken	-.14 (-1.97)

Producer surplus, the economic returns above variable costs of production is identified as a measure of producer welfare, from farm level production and farm price. Initially the base model has producer surplus identified at $518,971,000. The two illustrative simulations of 'what might have happened if' to the synthetic model of 2001 Canadian chicken market are :

1. – what might have happened if the price of beef had dropped (an attempt to illustrate the impact of the May 2003 BSE impact on the market) and
2. – what might have happened if all exports to other countries were suddenly constrained to zero

All simulation results are presented as the percent change from the base case and as such can be negative to illustrate a reduction in that variable or positive to show an increase. The simulation is deterministic and does not take into account any error that might be in the parameters or variables. The simulation results can be examined under a number of different scenarios depending upon the policy responses from industry. Purely as an illustration of what could happen the two simulations presented below assume that farm price and farm supply remain at their actual levels. This means that neither of these assumed 'shocks' to the system could have an impact on farm level profits. The shocks will impact on quantities consumed of various products, retail prices, distribution of product from export to domestic market. Results of the one year simulation are given in

Table 19. The main variables that will be examined are, quantity on the domestic retail market (Qui), retail price (Pi), processor revenue (PRV) and total expenditure by consumers on chicken (TEXP) .

Table 19: Synthetic Model Simulation Results

Variable	Base	Simulation with Lower Beef Prices	Base	Simulation with Exports = 0
Consumer Expenditure 000$	$1834350	$1749700	$1051210	$1188450
Total Quantity consumed 000kg	407323	371090	209893	273564
Processor Revenue 000$	$1138210	$1054930	$362930	$306729
Premium breaded formed chicken- qty	17003	15597	9080	9080
Value priced breaded formed chicken-qty	2541	2426	1745	1745
Frozen breaded natural chicken-qty	3708	3431	2160	2160
Frozen flavoured chicken breast-qty	1258	1232	1034	1034
Frozen chicken breasts-qty	6603	5949	4250	4250
Frozen wings-qty	5076	5566	6327	6327
Stuffed Chicken-qty	1547	1434	803	803
Frozen chicken burgers-qty	1563	1519	1204	1204
Frozen breaded chicken burgers-qty	2168	2126	1872	1872
Frozen chicken parts-qty	466	427	249	249
All other frozen chicken-qty	2520	2563	255	255

Fresh whole chicken-qty	164380	139970	43916	43916
Fresh chicken breast-qty	61049	60451	49168	49173
Drumsticks-qty	30202	27894	16747	16747
Chicken wings-qty	11540	11426	8350	11392
Chicken burger-qty	176	179	160	160
Chicken legs-qty	57616	52563	29274	77535
Chicken winglettes-qty	311	336	359	359
Chicken drumettes-qty	288	408	851	851
Chicken kabobs-qty	283	260	113	113
Chicken nuggets-qty	1385	1421	1221	1221
Chicken thighs-qty	26863	25283	16486	16486
Assorted chicken-qty	8767	8622	11967	24330
Premium breaded formed chicken-price	$6.81	$6.88	$6.81	$7.34
Value priced breaded formed chicken-price	$3.77	$3.78	=	$3.88
Frozen breaded natural chicken-price	$10.42	$10.45	=	$10.59
Frozen flavoured chicken breast-price	$10.90	$10.95	=	$11.32
Frozen chicken breasts-price	$8.66	$8.73	=	$8.97
Frozen wings-price	$9.77	$9.69	=	$9.58
Stuffed Chicken-price	$10.61	$10.71	=	$11.56
Frozen chicken burgers-price	$4.86	$4.86	=	$4.93
Frozen breaded chicken burgers-price	$6.96	$6.97	=	$7.01
Frozen chicken parts-price	$8.19	$8.22	=	$8.40

All other frozen chicken-price	$5.85	$5.83		=	$5.83
Fresh whole chicken-price	$2.71	$2.87		=	$4.30
Fresh chicken breast-price	$9.20	$9.22		=	$9.56
Drumsticks-price	$3.09	$3.15		=	$3.54
Chicken wings-price	$5.08	$5.10		$5.69	$5.10
Chicken burger-price	$4.69	$4.67		=	$4.77
Chicken legs-price	$2.16	$2.18		$2.33	$2.08
Chicken winglettes-price	$4.75	$4.74		=	$4.73
Chicken drumettes-price	$8.85	$8.75		=	$8.56
Chicken kabobs-price	$3.99	$4.19		=	$6.69
Chicken nuggets-price	$6.93	$6.89		=	$7.15
Chicken thighs-price	$4.17	$4.24		=	$4.72
Assorted chicken-price	$5.34	$5.35		$5.11	$4.63

The results presented above are from two different types of simulation. In the first case, the model simulates with fixed flows of product to export and food service markets, all adjustment is felt in the retail domestic market and distributed across all individual goods. The first two columns in the above table highlight the effect of lower beef prices across the chicken products consumed. Total consumer expenditure, total quantity of chicken consumed and processor revenue all decline in this scenario, however some chicken products consumption increases while others decrease (farm profit/producer surplus, supply and price are unaffected as they are held constant in this scenario). In the second simulation different variables are held exogenous, the products that have previously had exports are constrained to zero and those products are forced back onto the domestic market, affecting quantities of previously traded products (+), overall expenditure (+), processor revenue (-), total quantity consumed (+) . That this simulation produces different results is highlighted by the difference in the base values for total consumption, so the scenarios are not comparable across simulations, only comparable to the base in each case. The highly non-linear nature of the model under different sets of variables produces the variability in base quantities, Monte Carlo simulation including error terms back into the models could produce standard errors around these simulation results, although that exercise has not been completed yet. What is clear from the simulations however is that product substitutions are important to the outcomes of exogenous price or trade shocks in terms of aggregate levels of consumption, producer surplus and processor revenue from chicken sales.

MARKET STRUCTURE AND RETURNS TO ADVERTISING AND RESEARCH[4]

In the Canadian chicken 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 products. As part of a sustainable profit maximization plan, 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 they 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. The interactions and strategic planning of processors and retailers are becoming industry defining characteristics, not only affecting processors and retailers but also producers and consumers. Ultimately, the actions of the processors and retailers have an increasing influence on societal welfare.

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/manufacturers, and 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.

[4] Much of this final section of the report is taken directly from an unpublished Masters thesis by Ben Shank, 2004.

Increasing concentration and possibly market power exploitation mark the Canadian industry. Cotterill (2000) and Dhar 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 include a more disaggregated model, a two stage industry market channel, and explicit models of retailer and processor actions with the possibility of non-competitive behavior. The deviation away from competitive markets with a small number of firms are often classified as models of noncooperative oligopoly (Carlton and Perloff, 2000). In such a model, oligopolists cannot ignore the actions of other firms. In the extremes, a monopoly 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 monopoly and perfect competition, an oligopolistic firm realizes that the actions of other firms affect its own best policy.

The initial objective of this part of the research project is to empirically examine the market structure of the Canadian chicken market. This objective includes modeling demand and processor strategic conduct for individual products competing in an oligopoly market. The estimated model can be used to analyze the size and distribution of benefits from producer investments in advertising and research under an appropriate characterization of the existing market structure. The research will expand upon the previous research of Cotterill (2000), Dhar and Cotterill (2002), maintaining noncompetitive, differentiated product, dual stage market channel assumptions but also including brand and generic product advertising and farm supply effects. While previous agricultural commodity research has addressed advertising effects under different assumptions about competitive structure, none have used a non-cooperative, dual stage marketing channel with explicit game structures. Much of the marketing channel research has focused on the cost past through rates with constant (farm level) marginal costs. The addition of farm level positively sloped supply equations rather than constant marginal costs will be explored. The potential implications for market participants (including farmers) from changes in advertising expenditure will be examined using the noncompetitive differentiated product, dual stage market channel assumptions.

Related Literature

Although there is an abundance of literature on the economic impacts of generic advertising and there is an understanding of the link between producer returns and market structure, the literature on returns to generic advertising under imperfect competition is not that voluminous. A summary of some of the relevant literature in this area is provided in Table 20

Table 20: Studies Examining Generic Advertising under Imperfect Competition

Study and Year	Analysis	Conclusion
Zhang and Sexton (2002) ***Optimal commodity promotion when downstream markets are imperfectly competitive***	General model formulation, simulation for the cases of oligopoly, oligopsony and oligopoly/oligopsony	As compared to competitive markets: Optimal advertising intensity lower under oligopoly, unless the advertising makes demand more elastic and reduces the distortion from oligopoly power. Optimal advertising intensity always lower under oligopsony or oligopoly/oligopsony power
Zhang, Sexton and Alston (2002) ***Brand advertising and farmer welfare***	General model formulation, simulation	Brand advertising can: Increase demand for farm products or Increase market power of the advertising firm, leading to reduced farm sales
Depken, Kamerschen and Snow (2002) ***Generic advertising of intermediate goods: theory and evidence on free riding***	General model formulation, econometric dairy model example	Generic advertising can arise voluntarily, positive contributions will be linked to high advertising elasticities, lower price elasticities and larger firm size. The problems of free riders can be handled through making advertising contributions mandatory.
Wohlegenant and Piggott (2003) ***Distribution of gains from research and promotion in the presence of market power***	General model formulation, simulation For the case of oligopoly power	Results suggest a more important role for processor input substitutability than for market power in affecting level and distributional effects of promotion and research
Cardon and Pope (2003) ***Agricultural market structure, generic advertising and welfare***	General model formulation, comparative statics	Generic advertising can be socially beneficial in the case where competitive farm industry competes with a monopoly/monopsony downstream distributor. Generic advertising would lead to an increase in the monopolist's output

All of the above studies are essentially exploratory in nature and provide us with meaningful insights as to expected reactions to generic advertising under different market structures. The suggestion that market power has the potential to increase producer surplus response to generic advertising is particularly important. While it is clear that prices, quantities and revenues/profits are higher for primary producers in competitive markets than in markets where they face monopoly/oligopoly and/or monopsony/oligopsony market power, the returns to advertising can potentially be higher under the market power scenario. To illustrate this finding, reported above by Zhang and Sexton, a simple example can be used.

It is possible to construct a simple synthetic model of a marketing channel with one product produced at farm level, transformed by processors and retailers, and sold at retail level to final consumers. The exact marketing relationships will vary depending upon the market structure, as illustrated in Table 21.

Table 21: Different Market Structure Hypotheses with homogeneous product produced and consumed

Market Structure: Competition	Market Structure: Oligopoly	Market Structure: Monopoly
Assume a commodity market with fixed proportion processing technology, producers pay for generic advertising • Retail Demand Q=a - b*P-c/ADV • Processor Demand Q=f + d*P-e*PF • Farm Supply Q=g + h*PF • Producer Surplus PS=PF*Q-((.5/h)*Q**2-g/h*Q)-ADV	Assume a commodity market with fixed proportion processing technology, producers pay for generic advertising and processor/retailer oligopoly market power exists: • Retail Demand Q=a-b*P-c/ADV • Processor Demand Q=f + d*P-e*PF • Retail Price P=PF/(1-θ/(η)) (θ=conjecture, η=elasticity) • Farm Supply Q=g + h*PF • Producer Surplus PS=PF*Q-((.5/h)*Q**2-g/h*Q)-ADV	Assume a commodity market with fixed proportion processing technology, producers pay for generic advertising and processor/retailer monopoly market power exists: • Retail Demand Q=a-b*P-c/ADV • Processor Demand Q=f + d*MR-e*PF • Marginal Revenue MR= -a/b + c/(b*ADV) + 2/b*Q • Farm Supply Q=g + h*PF • Producer Surplus PS=PF*Q-((.5/h)*Q**2-g/h*Q)-ADV

Although it is quite clear even from the above that the producer surplus will get progressively lower as you move from left to right, the real question of what happens when you increase advertising expenditure is not so clear. With some example numbers the following empirical results are illustrative.

Table 22: Example Results from Increasing Advertising Expenditure with the base for each structure calibrated to produce the same price and quantity

Variable	**Base**	**Perfect Competition**	**Oligopoly (θ=.1)**	**Monopoly**
η_{adv}=.5		*Double generic advertising*	*Double generic advertising*	*Double generic advertising*
Retail Price	\$6.85	\$7.71	\$7.70	\$7.63
Farm Price	\$5.00	\$5.31	\$5.32	\$5.36
Quantity	320	350	350.4	354
Processor Profit	\$592	\$838 **(41.5%)**	\$835 **(41%)**	\$806 **(36%)**
Producer Surplus	\$473	\$513 **(9.4%)**	\$519 **(9.7%)**	\$534 **(12.8%)**

Since the increased advertising makes the demand ‘more elastic’ (certain with linear functional forms) the ‘distortion from market power is reduced’ and the actual benefit (return per dollar invested in advertising) to producers is higher under monopoly conditions than under competitive market conditions. The question of whether or not processors/retailers also benefit from the generic advertising is interesting but not critical to the measurement of producer benefit; it provides a clue as to whether or not the advertising could partially be funded by processors and/or retailers, an innovation which could increase producer benefit more. If producer returns to advertising are affected by market structure; does it also matter what type of games result in the oligopoly market power? In the above conjectural elasticity example the type of market power does not change when advertising changes. The question of whether the outcome from different games, remaining within the oligopolistic structure, is also different for producers remains open.

Modelling Vertical Structure

The study of competitive interaction in market channels which are vertical in nature, i.e. producer to processor, processor to retailer, retailer to consumer, has evolved considerably in the marketing literature. Early agricultural economics studies concentrated on homogeneous products and models that assumed that the market channel was a single industry with competitive firms (Gardener, 1975; Heien, 1980; Kinnucan and Forker, 1987). McCorriston, Morgan, and Rayner (1998) maintain the assumptions of a homogeneous product and a single stage industry but relax the competitive industry assumption, much like the example above. It is not until one examines the marketing literature that one finds more sophisticated assumptions regarding the actual structure of the marketing channel with products distinguished by brand/product attribute. Recent marketing studies have explored conjectural variation, non-cooperative game theory models under Nash equilibrium (for example, Lal, 1990; Raju, Srinivasan, and Lal, 1990). Two notable studies by the University of Connecticut, Department of Agricultural Resource Economics, Food Marketing Policy Center are of interest. In these articles Cotterill (2000) and Dhar and Cotterill (2002) it is recognized that agricultural markets are often successive stage oligopolies. These research studies, as well as ones by Liang (1987) and Kadiyali, Vilcassim and Chintagunta (1996) use menu approaches to model non-competitive, differentiated product, dual or single stage market channels. The possibility of differentiating even a homogeneous farm product into different brands and examining the determination of various brand retail prices is potentially of some importance since there are many trends to either brand generic products (companies branding fresh meat products) or to move already branded products back to simpler lines, predominantly using generic and private label products (recent movements in eggs and milk in Australia). The one way in which these brand level demand models do not match up with the earlier agricultural economics literature is through the simple assumptions made regarding marginal costs faced by processors or retailers. In some empirical examples in the literature the implied marginal cost is derived as an econometric parameter, rather than included as an explanatory variable. In other it is assumed to be fixed, making the models inapplicable to determining the producer benefits of generic advertising.

Following Cotterill (2000) it is possible to identify a market structure based on some limiting assumptions:

Horizontal competition both at processing and retail level is Nash in prices

Vertical nature of competition between processors and retailers is captured by

1. a two stage vertical Nash model where each retailer chooses an exclusive processor and processors and retailers maximize profit simultaneously by determining wholesale and retail price

2. a two stage vertical Stackelberg game where in the first stage processors maximize profit by determining the retail price based on a reaction function of the retailer and in the second stage retailers maximize profit given a wholesale price.

Dyadic relationships, each retailer deals only with one processor .

For that model the demand functions of retailers can be defined as :

$q_1 = a0 + a1\ p_1 + a2\ p_2$

$q_2 = b0 + b1\ p_1 + b2\ p_2$

The retailer's cost function can be defined as :

$TC_1 = w1 * q_1$

$TC_2 = w2 * q_2$

The retailer's profit function can thus be defined as:

$\Pi_1^R = (p_1 - w1)q_1$

$\Pi_2^R = (p_2 - w2)q_2$

In the Vertical Nash game a linear mark-up at retail is conjectured by the processor on retail price so retail price can be assumed by the processor to be:

$p_1 = w1 + r1$

$p_2 = w2 + r2$ where r1 and r2 are the linear mark-ups for each retailer.

In the Vertical Stackelberg game, each processor develops a conjecture from the first order condition of the retailer so retail price can be assumed by the processor to be:

p_1= ½ w1 – 1/2a1 (a0-a2p_2)

p_2= ½ w2 – 1/2b2 (b0-b1p_1)

The processor marginal cost curves can be expressed as :

wmc1 = m + m1

wmc2 = m + m2 where m is the industry specific marginal cost (farm price) and m1 and m2 are processor specific cost components.

Given those costs the processor profit functions can be written as:

Π_1^P = (w1-m-m1) q_1

Π_2^P = (w2-m-m2) q_2.

The solution of the set of simultaneous equations, under the two hypothesized market structures, results in 'cost-pass-through' rates that are the same regardless of the structure of the game. This is illustrated in Table 4 below.

Table 23: Cost Pass Through Rates, fixed farm prices, two different structural games

Cost Pass Through Rates	**Vertical Nash**	**Vertical Stackelberg**
Effect of Farm Price Change on Retail Price 1 $\frac{\partial p_1}{\partial m}$	$\frac{(4\alpha_1-3\alpha_2)b_2}{-9\alpha_2 b_1+16\alpha_1 b_2}$	$\frac{(4\alpha_1-3\alpha_2)b_2}{-9\alpha_2 b_1+16\alpha_1 b_2}$
Effect of Farm Price Change on Retail Price 2 $\frac{\partial p_2}{\partial m}$	$\frac{(4b_2-3b_1)\alpha_1}{-9\alpha_2 b_1+16\alpha_1 b_2}$	$\frac{(4b_2-3b_1)\alpha_1}{-9\alpha_2 b_1+16\alpha_1 b_2}$
Effect of Firm 1 Specific Cost Change on Retail Price 1 $\frac{\partial p_1}{\partial m_1}$	$\frac{(4\alpha_1 b_2)}{-9\alpha_2 b_1+16\alpha_1 b_2}$	$\frac{(4\alpha_1 b_2)}{-9\alpha_2 b_1+16\alpha_1 b_2}$
Effect of Firm 1 Specific Cost Change on Retail Price 2 $\frac{\partial p_2}{\partial m_1}$	$\frac{(3\alpha_1 b_1)}{-9\alpha_2 b_1+16\alpha_1 b_2}$	$\frac{(3\alpha_1 b_1)}{-9\alpha_2 b_1+16\alpha_1 b_2}$
Effect of Firm 2 Specific Cost Change on Retail Price 1 $\frac{\partial p_1}{\partial m_2}$	$\frac{(3\alpha_2 b_2)}{-9\alpha_2 b_1+16\alpha_1 b_2}$	$\frac{(3\alpha_2 b_2)}{-9\alpha_2 b_1+16\alpha_1 b_2}$
Effect of Firm 2 Specific Cost Change on Retail Price 2 $\frac{\partial p_2}{\partial m_2}$	$\frac{(4\alpha_1 b_2)}{-9\alpha_2 b_1+16\alpha_1 b_2}$	$\frac{(4\alpha_1 b_2)}{-9\alpha_2 b_1+16\alpha_1 b_2}$

The addition of farm supply to the above model significantly increases the complexity of the various cost pass through rates. The farm supply equation selected could be of the following form:

$$m = pf = g + h\,(q_1 + q_2).$$

To illustrate the impact of farm supply on the cost pass through rates the following examples of one rate can be expressed:

Table 24: Example Increase in Farm Price: Cost Pass Through Rates for Retail Price *1*

	No farm supply $\frac{\partial p_1}{\partial m}$	Farm supply : Farm Price = g + h (q_1+q_2) $\frac{\partial p_1}{\partial g}$
Vertical Nash	$\frac{(4a_1 - 3a_2)b_2}{-9a_2b_1 + 16a_1b_2}$	$\frac{(b_2(-4a_1 + 3a_2 - 3a_2b_1h + 3a_1b_2h))}{(3a_2^2b_1h(-3+4a_1h+3b_1h) + a_1b_2(a_1h(16-15b_2h) + b_1h(13-12b_2h) + 16(-1+b_2h)) + a_2(a_1b_2h(13-12a_1h) + 3b_1^2h(-3+4b_2h) + 3b_1(3-4b_2h+2a_1h(-2+b_2h))))}$
Vertical Stackelberg	$\frac{(4a_1 - 3a_2)b_2}{-9a_2b_1 + 16a_1b_2}$	$\frac{(a_1(b_2(4-a_1h) + b_1(-3+a_2h)))}{(-a_2^2b_1h(-3+2a_1h+b_1h) + a_1b_2(16-8b_2h+b_1h(-5+2b_2h) + a_1h(-8+3b_2h)) + a_2(a_1b_2h(-5+2a_1h) + b_1^2h(3-2b_2h) + b_1(-9+6b_2h-2a_1h(-3+b_2h))))}$

It is worth noting that with the addition of farm supply the cost pass through rates for the two market structures become different.

It is also possible to illustrate the impact of advertising on the structural model, in the first instance assuming no farm supply. With the addition of advertising the following demand equations can be assumed:

$$q_1 = \alpha_0 + \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 / adv_1 + x_1 / adv_3$$
$$q_2 = b_0 + b_1 p_1 + b_2 p_2 + b_3 / adv_2 + x_1 / adv_3$$

Three different advertising variables are assumed, adv_1 which is brand advertising for product 1, adv_2 which is brand advertising for product 2 and adv_3 which is generic advertising affecting the demands for both goods.

Under the two different market structures the following example cost pass through rates can be expressed:

Table 25: Advertising Pass Through Rates for ADV_1 and ADV_3

	$\frac{\partial p_1}{\partial adv_3}$	$\frac{\partial p_1}{\partial adv_1}$
Vertical Nash	$\frac{3(3\alpha_2 - 4b_2)x_1}{adv_3^{\,2}(9\alpha_2 b_1 - 16\alpha_1 b_2)}$	$\frac{12\alpha_3 b_2}{adv_1^{\,2}(-9\alpha_2 b_1 + 16\alpha_1 b_2)}$
Vertical Stackelberg	$\frac{3(3\alpha_2 - 4b_2)x_1}{adv_3^{\,2}(9\alpha_2 b_1 - 16\alpha_1 b_2)}$	$\frac{12\alpha_3 b_2}{adv_1^{\,2}(-9\alpha_2 b_1 + 16\alpha_1 b_2)}$

From the above it is clear with fixed marginal costs the impact of a change in advertising expenditure on retail price is the same regardless of which game is being played vertically between processors and retailers. However from the above two examples it is clear that the addition of endogenous farm supply would make the impact of the two advertising variables different.

Modelling games between two processors and retailers with generic and branded products

It is possible to illustrate a somewhat more realistic market scenarios if one allows for the existence of both generic and branded products. For illustrative purposes another market scenario can be constructed assuming that the two retailers each sell some branded and some generic product. Each processor produces some branded and some generic product, each retailer still has a dyadic relationship with only one processor. The last simplifying assumption is that the generic product is sold at the same price by each processor and retailer. This scenario requires the addition of a third product demand relationship and the determination of the share of generic product sold by each retailer and processor (s_1).

The demand equations can be expressed as:

$$q_1 = \alpha_0 + \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + \alpha_4 / adv_1$$
$$q_2 = b_0 + a_2 p_1 + b_2 p_2 + b_3 p_3 + b_4 / adv_2$$
$$q_3 = c_0 + a_3 p_1 + b_3 p_2 + c_3 p_3 + c_4 / adv_3$$

where product 1 and 2 are the branded products and product 3 is the generic product sold by both retailers. The total costs associated with each product can be expressed as:

$$TC_1 = w_1 * q_1$$
$$TC_2 = w_2 * q_2$$
$$TC_3 = w3 * q_3$$

However the profit equations for each retailer are a function of their sales of the one branded product (either 1 or 2) and their share (s_1 or 1-s_1) of the generic product (3). The two profit functions can be expressed as:

$$\Pi_1^R = (p_1 - w_1) * q_1 + (p_3 - w_3) * s_1 * q_3$$
$$\Pi_2^R = (p_2 - w_2) * q_2 + (p_3 - w_3) * (1 - s_1) * q_3$$

The processor costs for each product are defined as below:

$$wmc_1 = pf + m_1$$
$$wmc_2 = pf + m_2$$
$$wmc_3 = pf + m_3$$

These costs associated with each product lead to the following profit functions for each processor, again related to the sales of their branded product and their share of the generic product sold:

$$\Pi_1^P = (w_1 - pf - m_1) * q_1 + (w_3 - pf - m_3) * s_1 * q_3$$
$$\Pi_2^P = (w_2 - pf - m_2) * q_2 + (w_3 - pf - m_3) * (1 - s_1) * q_3$$

Following the earlier structure the processors conjectures can either be of the Nash type expressed below:

$p_1 = w_1 + r_1$
$p_2 = w_2 + r_2$
$p_3 = w_3 + r_3$

or of the Stackelberg type where the y are a function of the retailer's first order condition with respect to each price. In a world where each retailer could charge a different price for the generic product the Stackelberg processor price conjectures would be as below:

$$p_1 = \frac{-a4 + adv_1(a_0 + a_2 p_2 + a_3 p_3 + a_3 p_3 s_1 - a_1 w_1 - a_3 s_1 w_3)}{2a_1 adv_1}$$
$$p_2 = \frac{b_0 + b_4 / adv_2 + a_2 p_1 + 2b_3 p_3 - b_3 p_3 s_1 - b_2 w_2 - b_3 w_3 + b_3 s_1 w_3}{2b_2}$$
$$p_3{}^1 = \frac{-a_3 adv_3(p_1 + p_1 s_1 - w_1) + s_1(c_4 + adv_3(c_0 + b_3 p_2 - c_3 w_3))}{2adv_3 c_3 s_1}$$
$$p_3{}^2 = \frac{c_4 - c_4 s_1 - adv_3(-2b_3 p_2 + c_0(-1+s_1) + a_3 p_1(-1+s_1) + b_3 p_2 s_1 + b_3 w_2 + c_3 w_3 - c_3 s_1 w_3}{2adv_3 c_3(-1+s_1)}$$

In the simulation illustrated here the generic product demand is priced at the same level regardless of which retailer sells the product. With or without the addition of farm supply the complexities of the above model structure make it difficult to illustrate algebraically the impact of advertising on retail and wholesale prices (and farm price in the case of endogenous farm supply).

To use the model as an illustrative tool various price, advertising and supply elasticities are assumed. The own and cross price elasticities are as expressed in the table below

Table 26: Assumed Own and Cross Price and Advertising Elasticities

	P_1	P_2	P_3	ADV
Q_1	-2	.5	.25	.25
Q_2		-1.5	.251	.25
Q_3			-1.75	.25

The assumed supply elasticity is 1.0. The model is run with and without fixed marginal costs (fixed farm price). The results in terms of aggregate quantity sold and farm price, with producer surplus retailer and processor profit are expressed below.

Table 27: Simulation Results from doubling Generic Advertising Expenditure with Fixed Marginal Cost

Model	Vertical Nash	Vertical Stackelberg
Farm Price	5	5
Quantity change	3.32 (2.5%)	3.13 (2.6%)
Producer Surplus change	-6.51 (-2.9%)	-6.47 (-2.9%)
Retailer 1 π change	5.29 (4.1%)	4.75 (4.7%)
Retailer 2 π change	5.97(4.4%)	5.72 (5.0%)
Processor 1 π change	10.17 (4.4%)	10.4 (4.4%)
Processor 2 π change	12.25 (4.7%)	12.25 (4.7%)

The results suggest a decline in producer surplus with the additional generic advertising; something that is sensible given that farm price does not change and producers must fund the additional advertising expenditure. The generic advertising expenditure increase affects all quantities sold in the market slightly. The processors and retailers each benefit from the increased generic advertising and sales of all three products increase, product 3 sales increase the most.

The results from the model simulation with endogenous farm supply are more useful and are summarized below.

Table 28: Simulation Results from doubling Generic Advertising Expenditure with Variable Marginal Cost

Model	Vertical Nash	Vertical Stackelberg
Farm Price change	.033 (1.5%)	.036 (1.3%)
Quantity change	2.11 (1.4%)	2.37 (1.6%)
Producer Surplus change	4.67 (3.0%)	5.35 (3.2%)
Retailer 1 π change	2.42 (1.6%)	3.7 (2.4%)
Retailer 2 π change	3.27(2.0%)	3.72 (2.9%)
Processor 1 π change	10.83 (2.6%)	10.93 (2.5%)
Processor 2 π change	13.38 (3.2%)	13.21 (3.1%)

With the endogenous farm supply the results again suggest an increase in quantity sold, with an attendant increase in farm supply and price. The impact on quantity and price are somewhat larger with the Stackelberg structure than with the Nash structure. The increase in farm supply and price results in a positive impact on producer surplus, greater than the cost of the additional advertising expenditure. Retailers and processors both benefit from the additional generic advertising.

Returns to Research and Development

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 .

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

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. In a manner similar to the previous exposition about returns to advertising models can be specified which examine the returns to research in the context of imperfectly competitive market structures where processors and retailers are pa-laying pricing games within a vertical market channel.

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

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

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

$$\pi_i = (p_i - mc_i)q_i \qquad (3.2)$$

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),

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 ($\varepsilon_1 \ldots \varepsilon_{n+i}$) 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.

Stackelberg Game

In a price leadership or Stackelberg game, one processor (processor *k*, where *k* =1…*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,

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

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

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.

$$\pi_k = (p_k - mc) q_k \qquad (3.8)$$

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

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

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.

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

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.

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

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

(3.11 b)

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

where i =1…n, excluding $i = k$.

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,

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

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

Empirical Model Estimation and Selection

Data

For the Canadian chicken market, 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.

Figure 14: Weekly Canadian Fresh Chicken Retail and Producer Prices (2001:1-2003:44)

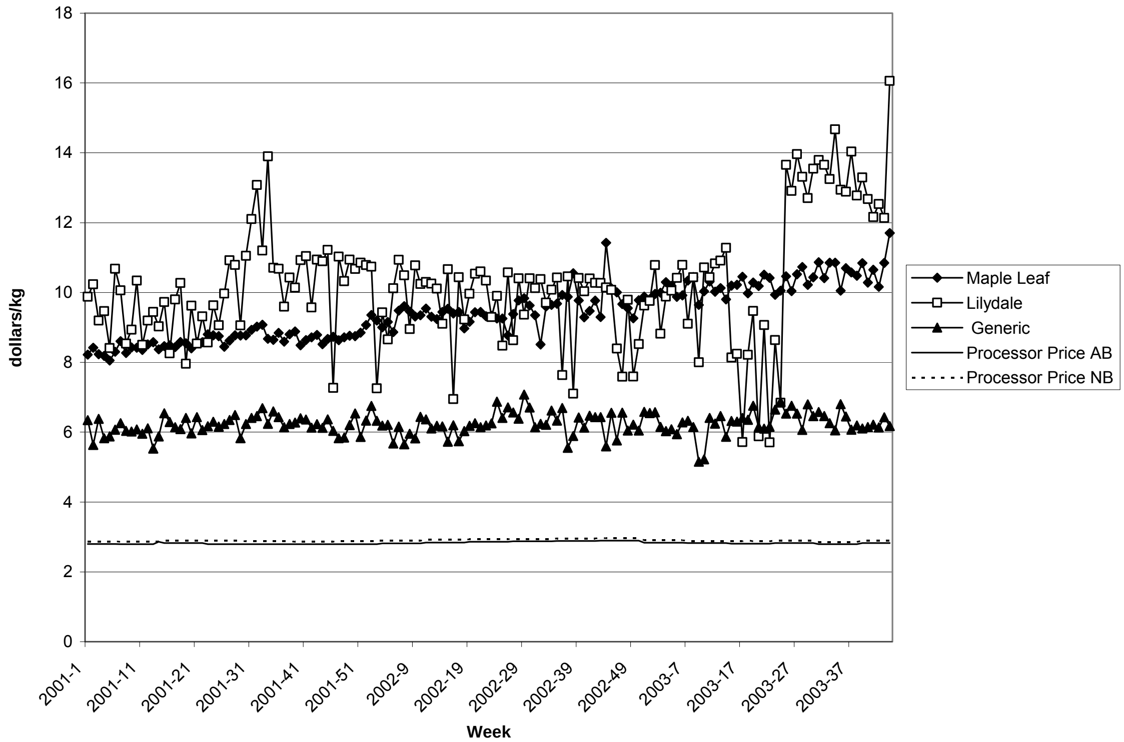


Figure 15: Weekly Canadian Fresh Chicken Retail Sales by Volume (2001:1-2003:44)

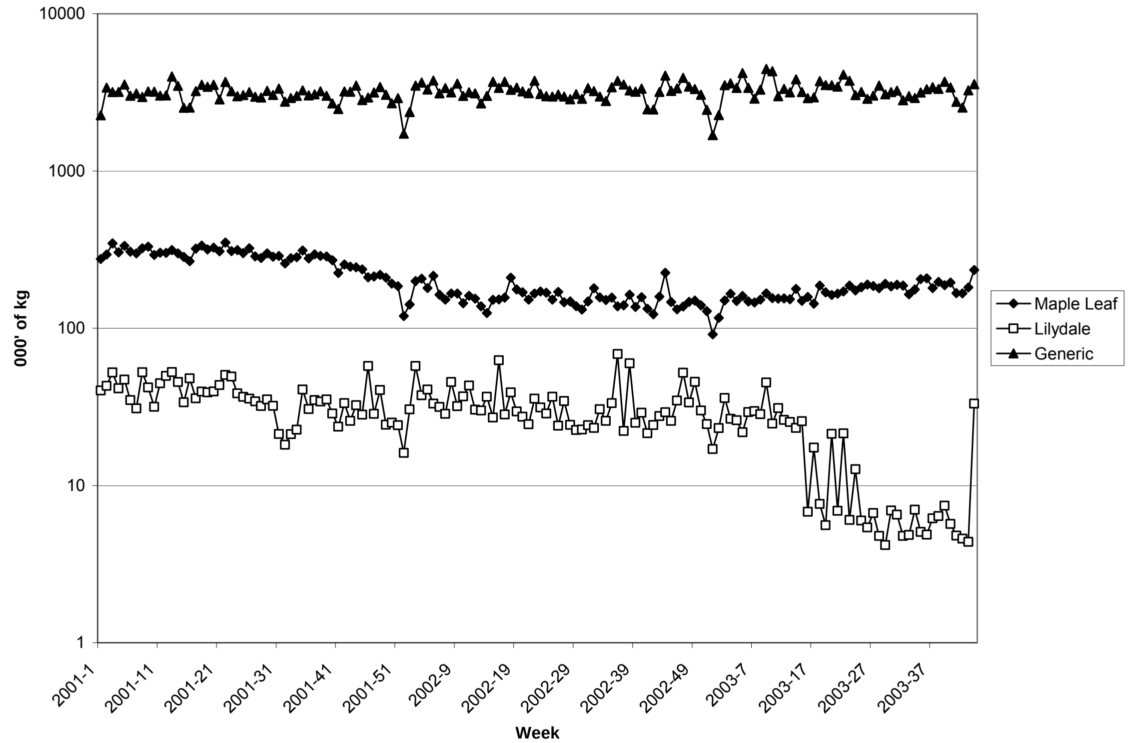
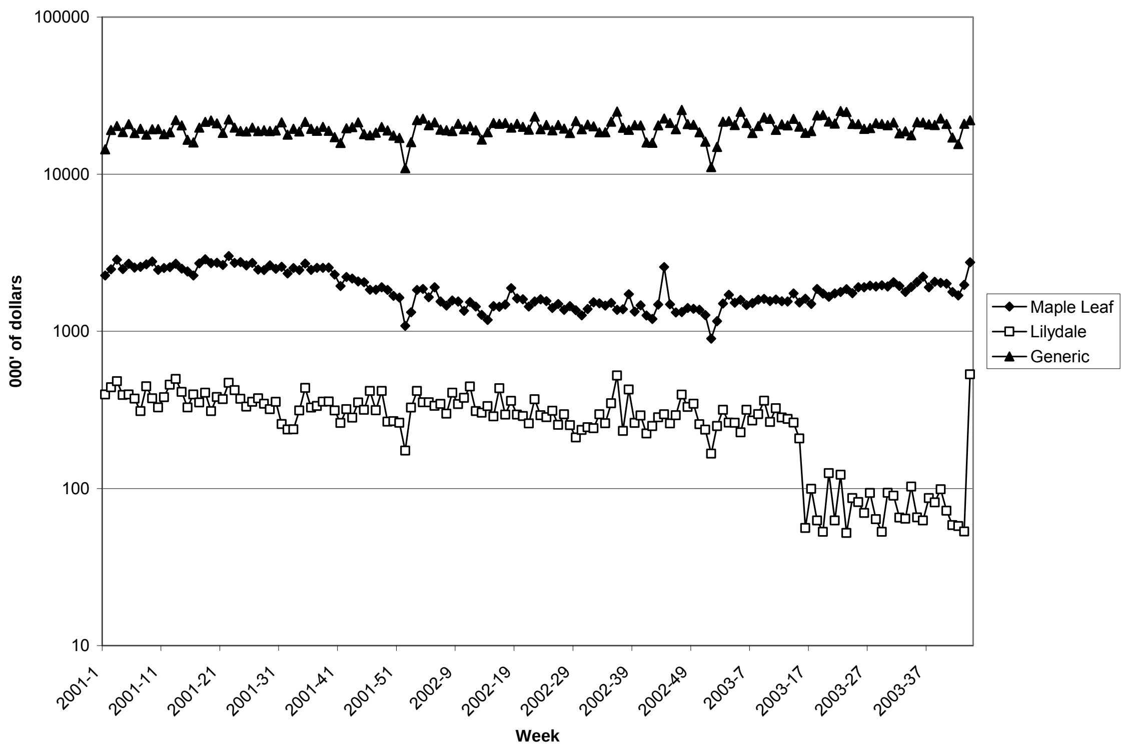


Figure 16: Weekly Canadian Fresh Chicken Retail Sales by Value (2001:1-2003:44)



Empirical Estimation

Using Times Series Processor (TSP) software SUR was performed assuming three chicken processors: (1) Lilydale, (2) Maple Leaf Prime, and (3) Generic. Using a generalized equation system format, nine SUR estimations were completed; two Bertrand-Nash models and seven Stackelberg. R-squared values (Table 29) 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 30 to 32 summarize Marshallian demand elasticities, Hicksian demand elasticities, and price reaction elasticities.

Table 29: 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 30: 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									
$\varepsilon 11$	-1.355*	-0.705*	-1.341*	-1.357*	-1.293*	-1.099*	-1.304*	-1.293*	-1.293*
$\varepsilon 22$	-0.812*	-0.866*	-0.489*	-0.810*	-0.693*	-0.700*	-0.698*	-0.690*	-0.695*
$\varepsilon 33$	-1.187*	-1.217*	-1.174*	-1.166*	-1.095*	-1.089*	-1.080*	-1.094*	-1.093*
Cross Price Elasticity									
$\varepsilon 12$	1.673*	1.727*	2.332*	1.601*	2.231*	3.397*	2.190*	2.231*	2.232*
$\varepsilon 13$	-0.787*	-1.431*	-1.299*	-0.610**	-1.257*	-2.154*	-1.178*	-1.252*	-1.270*
$\varepsilon 21$	0.255*	0.263*	0.355*	0.244*	0.340*	0.517*	0.333*	0.340*	0.340*
$\varepsilon 23$	0.376*	0.695*	0.228	0.184	-0.139	-0.171	-0.199	-0.150	-0.127
$\varepsilon 31$	-0.012*	-0.021*	-0.019*	-0.009**	-0.019*	-0.032*	-0.017*	-0.019*	-0.019*
$\varepsilon 32$	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≤ 0.05
** Significance assumed at P≤ 0.10
Where for *εij*, *i* and *j* take the values: 1-Lilydale, 2-Maple Leaf, 3-Generic

Table 31: 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									
$\varepsilon 11$	-1.350*	-0.691*	-1.335*	-1.352*	-1.284*	-1.090*	-1.294*	-1.284*	-1.284*
$\varepsilon 22$	-0.710*	-0.781*	-0.375*	-0.710*	-0.597*	-0.595*	-0.602*	-0.593*	-0.599*
$\varepsilon 33$	-0.319*	-0.342*	-0.318*	-0.296*	-0.222*	-0.224*	-0.207*	-0.222*	-0.220*
Cross Price Elasticity									
$\varepsilon 12$	1.706*	1.818*	2.366*	1.634*	2.293*	3.454*	2.251*	2.293*	2.294*
$\varepsilon 13$	-0.448	-0.494	-0.954*	-0.264	-0.620	-1.565*	-0.546	-0.615	-0.635
$\varepsilon 21$	0.270*	0.276*	0.372*	0.259*	0.354*	0.533*	0.348*	0.354*	0.354*
$\varepsilon 23$	1.428*	1.569*	1.393*	1.210*	0.851*	0.910*	0.787*	0.839*	0.864*
$\varepsilon 31$	0.001	-0.008**	-0.007	0.004	-0.006	-0.019*	-0.005	-0.006	-0.006
$\varepsilon 32$	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 32: 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 ε p*i*(p*j*), is the price reaction equation elasticity for processor *i* with respect to price .*j*
Where ε p*i*(mc), is the price reaction equation elasticity for processor *i* with respect to marginal cost.
i and *j* take the values: 1-Lilydale, 2-Maple Leaf, 3-Generic

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, 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 table illustrates the sum of squared errors by price equation and in total.

Table 33: 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

*Preferred model

In Canadian 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).

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 Canada, 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.

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 Canada. The market data indicates that, in terms of volume and value, generic processors in Canada lead the market. Additionally in Canada the preferred model has Lilydale acting as a cooperative but other market participants still treating 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 make up a significant portion of chicken demand. The primary assumption behind this theory is that profits are higher under cooperative action. Therefore, noncooperative behavior in one market reduces the credibility of players 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.

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 34: 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 $P \leq 0.10$

Both positive and negative cross price elasticities are observed for the Canadian market. 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 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,. 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 35: 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 ≤ 0.10

Previously assumed gross complements, Lilydale 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.

Synthetic Model Development

To assess the potential impact of generic advertising and research in the Canadian market, 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

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

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

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

Parameter estimates are then calculated by

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

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 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 replications, both mean quantity and prices predictions, as well as confidence intervals can be calculated. Table 36 illustrates a summary of the equations estimated in each synthetic model.

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 Table 37 . 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.

Given this base model, four simulations for the 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 Tables 38 through 44. Discussion of results proceeds in the next section.

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 beneficial to Canadian producers, research in Canada is counterproductive (Tables 38, 39, 40 and 41). In Canada the success of advertising investment is largely due to the increase in quantity marketed as farm prices remain relatively stagnant (Table 37). The increase in quantity more than offsets the increase investment expenditure. The increase in quantity is not great enough to compensate for the increase investment expenditure. When considering returns to research, Canada exhibits negative returns on investment (Table 39 and 40). 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 in Canada, while research investment is negative. 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 were 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 41). 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 37). When considering research investment in Canada, the gains in quantity and retail price are not large enough a produce positive return for all processors. Rising marginal cost influences some processors more than others and produces negative returns. It is noted that in the investigation of both produce and processor returns the confidence intervals seem relatively narrow. In 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 (Tables 41, 42, 43, and 44). 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.

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. 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.

Table 36: 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] $mc_i = fp + basis$
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 Canadian Simulation

Table 37: Canadian Synthetic Model with Increasing Advertising Investment: Prices and Quantities

	Starting Values	Advertising Investment $750,000 Mean	95% Confidence Interval Lower Bound	Upper Bound	Std Dev	Advertising Investment $1,000,000 Mean	95% Confidence Interval Lower Bound	Upper Bound	Std Dev
Quantity (000's kg)									
q1	931.3	932.8	932.8	932.8	7.8E-02	933.5	933.5	933.6	1.2E-01
q2	8643.9	8652.4	8652.4	8652.5	4.5E-01	8656.6	8656.5	8656.7	6.8E-01
q3	170289.0	170386.1	170385.3	170387.0	5.1E+00	170433.5	170432.2	170434.7	7.7E+00
Prices ($/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 38: Canadian Synthetic Model with Increasing Research Investment: Prices and Quantities

	Starting Values	Research Investment $750,000 Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Std Dev	Research Investment $1,000,000 Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Std Dev
Quantity (000's kg)									
q1	931.3	931.8	931.8	931.8	2.1E-02	932.4	932.4	932.4	4.1E-02
q2	8643.9	8646.0	8646.0	8646.0	9.2E-02	8648.3	8648.3	8648.3	1.8E-01
q3	170289.0	170432.1	170431.1	170433.1	6.0E+00	170581.6	170579.7	170583.5	1.2E+01
Prices ($/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 39: Canadian Synthetic Model with Increasing Advertising Investment: Producer Returns

Producers Selling to	Base Model	Advertising Investment $7500,000	95% Confidence Interval		Advertising Investment $1,000,000	95% Confidence Interval	
	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 40: Canadian Synthetic Model with Increasing Research Investment: Producer Returns

Producers Selling to	Base Model	Research Investment $7500,000			Research Investment $1,000,000		
			95% Confidence Interval			95% Confidence Interval	
	Mean	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	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 41: 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 42: 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 43: 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 44: Canadian 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							
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

SUMMARY AND CONCLUSIONS

In this research a number of different studies have been summarized. The common theme in all of the studies is the complexity of consumer behaviour with regard to chicken products within Canada. Within the chicken industry economic analysis in the past has tended to focus on the aggregate demand for chicken, as a commodity. The results reported suggest that at the consumer level, chicken fresh and frozen products are not perceived to be perfect substitutes, within a narrow category such as fresh chicken breasts, they are not perceived as even close substitutes, within the fresh category branded products such as those developed by Lilydale and Maple Leaf are not perceived as perfect substitutes. As well, an initial look at the demand for individual chicken products by household suggests that there is far from a common buying pattern across Canadian households, even within a single province.

Why do we need to know about consumer behaviour with regard to disaggregated chicken products? Initial simulation results have shown that the impact of shocks such as a change in beef price or the necessity to suddenly reduce exports (perhaps due to an outbreak of Avian flu) could affect different sectors, products and firms within the industry very differently, driven by the consumer substitutability of the various chicken products. Firm level behaviour can directly affect the aggregate level of chicken product sold and the returns to producers from investments in things such as generic advertising and basic research. Although there is a lot more research to do (current research on pricing strategic games in frozen chicken products, for example) clearly a deeper understanding of the games being played in the Canadian chicken marketplace will enhance our ability to model policy and exogenous shocks to the sector.

One of the original aims of the research was to model the consumer demand for production attributes (free run, organic, etc.) . Unfortunately the data did not support this type of analysis; until this month the most recent household level data purchases available for study (purchased through a research grant from the Alberta Prion Research Institute obtained in 2006) contained far too few products that were so identified and many products for which the production attributes could not be identified at all. In some senses the analysis of fresh chicken products from Maple Leaf as opposed to Lilydale might be perceived as a competition between different types of production systems (based on the advertising campaigns of Maple Leaf). For a while shortly after May 2003, when BSE was found in an Alberta cow, Maple Leaf advertised its meat products as coming from animals that were 100% grain fed; Lilydale only referred to vegetable product fed without the numerical descriptor. However this is a very subtle difference for consumer to grasp onto. With a more recent data purchase of data on household purchases of meat from January 2006 to June 2007 to augment the earlier data set and the ability to get more product description from the UPC codes associated with the individual products, further analysis of demand for production attributes might be possible in the future.

Further analysis of the results reported in this paper are possible in a number of different categories:

- disaggregation of more individual products by brand
- different categorization of chicken products by nutrient content (using detailed product descriptions from Canadian stores)
- longer analysis over the years 200 to 2007
- more simulations of the two models reported under a wider variety of exogenous or policy shocks
- different model specifications under market structures established by estimation for a wider variety of chicken products
- further analysis of the impact of new product introductions into the marketplace – do they displace current products, why do some not succeed? (ongoing in an existing research project at the University of Alberta).

The results reported to date suggest that investment strategies and different policy outcomes will all be affected by and enhanced by a deeper understanding of the Canadian chicken consumer, the fundamental driving force in market outcomes.

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