**University of Alberta**

*What has been causing the decline in beef consumption in Canada?*

by

*José Luis Lomeli* ©

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# Abstract

In this study, the measurement of the changes in meat demand based not only on price and income changes, but also upon consumers' perception of healthfulness and safety of the meats involved, advertising and demographic characteristics is undertaken.

Results indicate that although total expenditure on aggregate meat is significantly and negatively impacted by food safety issues, the demand for specific meats (beef, pork and chicken) does not appear to have been significantly affected by them. Health concerns have had an effect on total expenditure on meats and, individually, on beef and pork consumption. Advertising has been a statistically significant source of increased consumption of meat.

At the household level, food safety issues, health concerns and advertising have led to changes in total household expenditures on meat. As well, food safety issues and health concerns have had an impact on the demand for specific meat cuts. Demographic characteristics play a significant role in determining the impact of prices, food safety issues and health concerns on Canadian household meat consumption.

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# Table of Contents

Chapter 1 Introduction ..... 1
**1.1 Background** ..... 1
**1.2 Economic Problem** ..... 9
**1.3 Research Objectives** ..... 11
Chapter 2 Literature Review ..... 14
**2.1 Introduction** ..... 14
**2.2 Consumer Theory** ..... 14
**2.2.1 Utility maximization (expenditure (cost) minimization)** ..... 15
**2.2.2 Weak Separability and Utility Trees** ..... 18
**2.3 Meat Demand** ..... 20
**2.3.1 Time Series vs. Cross Sectional Analysis** ..... 20
**2.3.2 Different Functional Forms** ..... 22
**2.3.3 Demand Systems vs. Single Equations** ..... 24
**2.3.4 How to Include Information Variables in Demand Systems?** ..... 24
**2.4 The Effect of Information on Meat Demand** ..... 27
**2.4.1 Creation of Information Indices (News Indices)** ..... 27
**2.4.2 Health and Meat Consumption** ..... 35
**2.4.2.1 Is It True that Red Meats are Bad for One's Health?** ..... 35
**2.4.2.2 Health Risk from Meat** ..... 35
**2.4.2.3 Health Benefits from Meat** ..... 36
**2.4.3 Meat Demand and Health** ..... 39
**2.4.4 What is Food Safety?** ..... 40
**2.4.4.1 Bovine Spongiform Encephalopathy** ..... 41
**2.4.4.2 Escherichia coli** ..... 43
**2.4.4.3 Salmonella** ..... 43
**2.4.4.4 Other Diseases** ..... 44
**2.4.5 Food Safety and Meat Demand** ..... 44
**2.4.6 Social Marketing** ..... 45
**2.4.6.1 Heart and Stroke Foundation of Canada (Health Check Program)** ..... 46
**2.4.6.2 Canadian Cancer Society (5 to 10 a day... Are You Getting Enough?)** ..... 47
**2.4.6.3 Office of Nutrition Policy and Promotion at Health Canada (Canada's Food Guide)** ..... 48
**2.4.6.4 Canadian Diabetes Association (Healthy Eating is in Store for You)** ..... 49

2.4.6.5 Dietitians of Canada (Eat Well, Live Well)....50
2.4.6.6 General Comments on Social Marketing. Can These Programs Increase Nutrition Awareness and Impact Food Consumption Choices?....51
2.4.7 Effects of Advertising (Generic, Brand, Restaurant)....52
2.4.8 Demographic Changes and Product Development....55
2.5 Summary of Canadian Studies....56
2.6 Summary of Literature Review....59
Chapter 3 Methods....61
3.1 Introduction....61
3.2 Description of Functional Forms....61
3.2.1 Generalized Box-Cox....63
3.2.2 Almost Ideal Demand System....68
3.3 Use of Media Indices....71
3.3.1 Time Series Indices....72
3.3.2 Cross Sectional Media Indices....72
3.4 Hypothesis Testing....72
3.5 Derivation of Elasticities....73
3.6 Two-Stage Modeling....73
3.7 Rank of a Demand System....74
3.8 Zeros in Cross Sectional Analyses....75
3.9 Summary....78
Chapter 4 Time Series Results....80
4.1 Introduction....80
4.2 Time Series Data....80
4.3 Estimation Results....90
4.3.1 Price Elasticities....94
4.3.2 Generic Advertising Elasticities....96
4.3.3 Brand Advertising Elasticities....97
4.3.4 Restaurant Advertising Elasticities....98
4.3.5 Food Safety Elasticities....100
4.3.6 Health Elasticities....101
4.4 Simulation Results....102
4.5 Comparison to Previous Studies....106
4.6 Summary....111

Chapter 5 Cross Sectional Results ........ 114
**5.1 Introduction** ........ 114
**5.2 Cross Sectional Data** ........ 114
**5.3 Some Descriptives** ........ 116
**5.4 Estimation Results** ........ 120
**5.5 Demographic Elasticities** ........ 129
**5.6 Other Impacts of Demographics** ........ 139
**5.7 Summary** ........ 141
Chapter 6 Conclussions ........ 144
**6.1 Introduction** ........ 144
**6.2 Summary of the Study** ........ 144
**6.3 Comparison of Time Series and Cross Sectional Results** ........ 148
**6.4 Implications** ........ 154
**6.5 Beef Consumption** ........ 156
**6.6 Contribution** ........ 158
**6.7 Further Research** ........ 159
References ........ 165
Appendix A ........ 184
Appendix B ........ 205
Appendix C ........ 208
Appendix D ........ 209

# List of Tables

Table 3-1 Summary of characteristics of the functional forms used in this thesis ........ 62
Table 4-1 Log-likelihood ratio test results for model specification ........ 92
Table 4-2 Nonlinear multiple regression estimates of the total expenditure function for meat consumption in Canada, 1978-2001 ........ 93
Table 4-3 Across two-stage, own- and cross-price elasticities of demand for the Canadian meat market ........ 95
Table 4-4 Second stage, own- and cross-price elasticities of demand for the Canadian meat market ........ 95
Table 4-5 Across two-stage, own- and cross-generic advertising elasticities of demand for the Canadian meat market ........ 97
Table 4-6 Second stage, own- and cross-generic advertising elasticities of demand for the Canadian meat market ........ 97
Table 4-7 Across two-stage, own- and cross-brand advertising elasticities of demand for the Canadian meat market ........ 98
Table 4-8 Second stage, own- and cross-brand advertising elasticities of demand for the Canadian meat market ........ 98
Table 4-9 Across two-stage, own- and cross-restaurant advertising elasticities of demand for the Canadian meat market ........ 99
Table 4-10 Second stage, own- and cross-restaurant advertising elasticities of demand for the Canadian meat market ........ 99
Table 4-11 Across two-stage, own- and cross food safety elasticities of demand for the Canadian meat market ........ 100
Table 4-12 Second stage, own- and cross food safety elasticities of demand for the Canadian meat market ........ 101
Table 4-13 Across two-stage, own- and cross health elasticities of demand for the Canadian meat market ........ 102
Table 4-14 Second stage, own- and cross health elasticities of demand for the Canadian meat market ........ 102
Table 4-15 Simulation results, changes in per capita beef, pork and chicken disappearance due to changes in various variables ........ 104
Table 4-16 Own-price elasticities for beef, pork and chicken, a comparison to various studies on Canadian meat demand ........ 107

Table 4-17 Own-generic advertising elasticities for beef, pork and chicken, a comparison to various studies ......... 108
Table 4-18 Own-brand advertising elasticities for beef, pork and chicken, a comparison to various studies ......... 109
Table 4-19 Own-restaurant advertising elasticities for beef, pork and chicken, a comparison to various studies ......... 109
Table 4-20 Food safety elasticities for beef, pork and chicken, a comparison to various studies 110
Table 4-21 Health elasticities for beef, pork and chicken, a comparison to various studies ........ 110
Table 4-22 Summary of elasticity estimates ......... 112
Table 5-1 Characteristics of the Households Surveyed for the 1996 and 2001 Food Expenditure Surveys ......... 117
Table 5-2 1996 Food Expenditure Survey, Sample Data Covering Meat Consumption ......... 118
Table 5-3 2001 Food Expenditure Survey, Sample Data Covering Meat Consumption ......... 119
Table 5-4 Expenditure shares for the various meat cuts, 1996 and 2001 Food Expenditure Surveys ......... 120
Table 5-5 Log-likelihood ratio test results for model specification, 1996 Food Expenditure Survey ......... 121
Table 5-6 Log-likelihood ratio test results for model specification, 2001 Food Expenditure Survey ......... 122
Table 5-7 Multiple regression estimates of the total expenditure function for meat consumption in Canada, 1996 and 2001 Food Expenditure Surveys ......... 123
Table 5-8 First stage own-food safety elasticities, 1996 and 2001 Food Expenditure Surveys ... 124
Table 5-9 First stage own-health elasticities, 1996 and 2001 Food Expenditure Surveys ......... 124
Table 5-10 Across two-stage own- and cross-price elasticities, 1996 Food Expenditure Survey 125
Table 5-11 Second stage own- and cross-price elasticities, 1996 Food Expenditure Survey ...... 125
Table 5-12 Across two-stage own- and cross-price elasticities, 2001 Food Expenditure Survey 126
Table 5-13 Second stage own- and cross-price elasticities, 2001 Food Expenditure Survey ...... 126
Table 5-14 Second stage age elasticities, 1996 and 2001 Food Expenditure Survey ......... 128
Table 5-15 Second stage household size elasticities, 1996 and 2001 Food Expenditure Surveys ......... 128
Table 5-16 Second stage FAFH elasticities, 1996 and 2001 Food Expenditure Survey ......... 129
Table 5-17 Regional own-price elasticities, 1996 Food Expenditure Survey ......... 130
Table 5-18 Regional own-price elasticities, 2001 Food Expenditure Survey ......... 131
Table 5-19 Regional food safety elasticities, 1996 Food Expenditure Survey ......... 132

Table 5-20 Regional food safety elasticities, 2001 Food Expenditure Survey ............................ 132
Table 5-21 Regional health elasticities, 1996 Food Expenditure Survey.................................... 133
Table 5-22 Regional health elasticities, 2001 Food Expenditure Survey.................................... 134
Table 5-23 Educational own-price elasticities, 1996 Food Expenditure Survey ......................... 135
Table 5-24 Income own-price elasticities, 2001 Food Expenditure Survey ................................ 136
Table 5-25 Educational food safety elasticities, 1996 Food Expenditure Survey........................ 137
Table 5-26 Income food safety elasticities, 2001 Food Expenditure Survey .............................. 138
Table 5-27 Educational health elasticities, 1996 Food Expenditure Survey............................... 138
Table 5-28 Income health elasticities, 2001 Food Expenditure Survey ...................................... 139
Table 5-29 Summary of elasticities, 1996 Food Expenditure Survey......................................... 143
Table 5-30 Summary of elasticities, 2001 Food Expenditure Survey......................................... 143
Table 6-1 Comparison of annual per capita meat disappearance and annual household meat consumption, 1996 and 2001 ....................................................................................... 149
Table 6-2 Time series and cross sectional own-price elasticity estimates for Canada................. 151
Table 6-3 Time series and cross sectional food safety elasticity estimates for Canada ............... 152
Table 6-4 Time series and cross sectional health elasticity estimates for Canada ....................... 153

## List of Figures


Figure 1-1 Beef demand index and per capita consumption, Canada, 1985 - 2002 ........................3
Figure 1-2 Pork demand index and per capita consumption, Canada, 1985 - 2002 ........................4
Figure 1-3 Chicken demand index and per capita consumption, Canada, 1985 -2002 ....................4
Figure 1-4 Per capita consumption of beef, pork and chicken in Canada (1968-2001) ..................5
Figure 2-1 Approaches to incorporating information sources into the consumer utility maximization problem ........................................................................................................27
Figure 4-1 Per capita consumption of beef, pork and chicken in Canada (1968-2001) .................81
Figure 4-2 Real prices for beef, pork and chicken in Canada (1981 dollars) ................................82
Figure 4-3 Beef, pork and chicken generic advertising real expenditures (1981 dollars) .............83
Figure 4-4 Beef, pork and chicken brand advertising real expenditures (1981 dollars) ................83
Figure 4-5 Beef and chicken fast food restaurant advertising real expenditures (1981 dollars) ....84
Figure 4-6 Annual per capita disappearance of beef, pork and chicken, and the food safety indices ........................................................................................................85
Figure 4-7 Annual per capita disappearance of beef, pork and chicken, and the net health indices ........................................................................................................86
Figure 4-8 Recommended number of servings in the various Canadian Food Guides .................87
Figure 4-9 Number of recommended meat servings as a percentage of total servings recommended, various Canadian Food Guides ........................................................................88
Figure 4-10 Number of recommended milk products servings as a percentage of total servings recommended, various Canadian Food Guides ........................................................................88
Figure 4-11 Number of recommended grain products servings as a percentage of total servings recommended, various Canadian Food Guides ........................................................................89
Figure 4-12 Number of recommended vegetables and fruit servings as a percentage of total servings recommended, various Canadian Food Guides ........................................................89
Figure 6-1 BSE and beef, Canadian vs. foreign issues, 1978 - 2001 ............................................161
Figure 6-2 E. coli and beef, Canadian vs. foreign issues, 1978-2001 ..........................................162
Figure 6-3 E. coli and pork, Canadian vs. foreign issues, 1978-2001 ..........................................162
Figure 6-4 Salmonella and pork, Canada vs. foreign issues, 1978 – 2001 ..................................163
Figure 6-5 E. coli and chicken, Canada vs. foreign issues, 1978 – 2001 ....................................163
Figure 6-6 Salmonella and chicken, Canada vs. foreign issues, 1978 – 2001 ............................164

# Chapter 1
# Introduction

## 1.1 Background

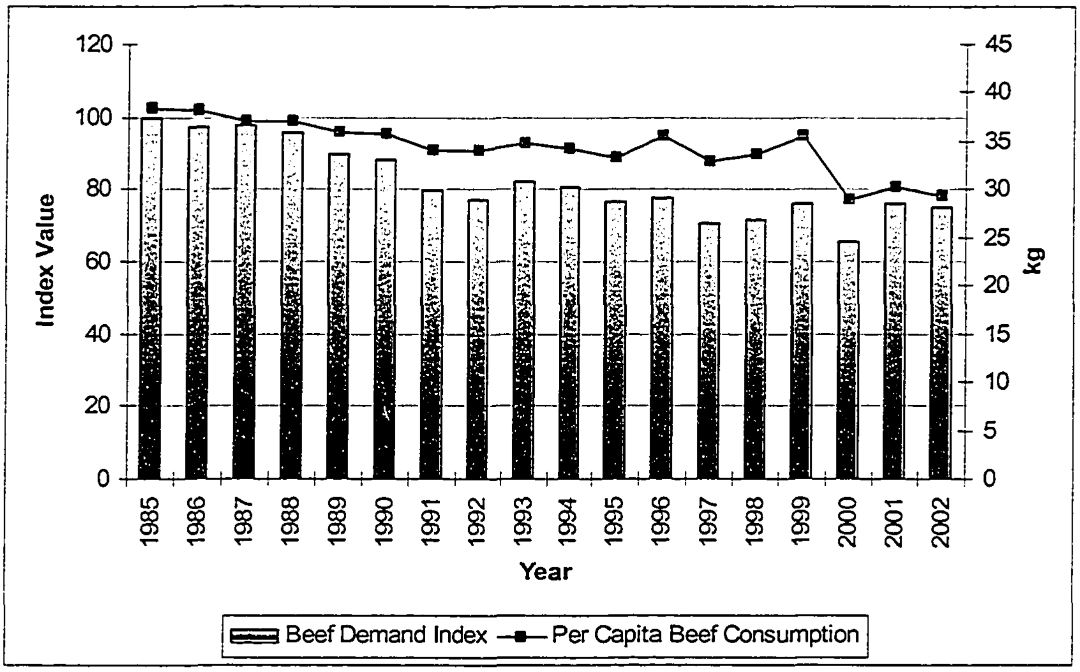
In the past ten years, the amount of professional attention paid to the consumer demand issues associated with the Canadian beef/cattle industry has been limited. The few exceptions include Chen and Veeman, Worley et al., Reynolds and Goddard (1991); Moschini and Vissa (1993); Eales (1996); Xu and Veeman (1996); Karantininis et al., Unterschultz et al. (1997); Quagrainie et al. (1998); Cranfield and Goddard (1999). The Canadian beef sector is a massive contributor to the Canadian economy. Even with the BSE crisis in 2003, the sector remains the largest single source of farm cash receipts ($5.2 billion in 2003, down from $7.6 billion in 2002) (Beef Information Centre, 2004a), contributing 15.25 percent of farm income (The Daily, 2004). In addition, beef production contributes to the processing, retail, food service and transportation sectors (Canadian Cattlemen's Association, 2001). In 2003, beef production added about $21 billion to the Canadian economy (Beef Information Centre, 2004a). In 2002, Canada exported 60 percent of its beef and cattle production, making Canada the third largest beef exporting nation in the world, after Australia and the U.S. This figure decreased to 34 percent in 2003 as a direct result of the single BSE case, when Canada ranked as the fifth largest beef and cattle exporter in the world (Beef Information Centre, 2004a).

Although over the past fifteen years the industry has consolidated, beef production does take place in every Canadian province with a total of 14.7 million head of cattle and calves. With 68 percent of Canada's fed cattle production, Alberta is by far the largest beef province, followed by Ontario, Saskatchewan, Manitoba, and BC. The

Atlantic Provinces and Quebec account for about 2 percent of total Canadian beef production. As well, the number of cows per farm has increased and there has been consolidation of beef farming operations; there were around 90,000 farms with beef cattle in 2001 and most herds (90 percent) were small to medium size with fewer than 122 head (Canadian Cattlemen's Association, 2004). Ten percent of the farms (with over 122 head) that report cows now hold 40 percent of the Canadian herd (Beef Information Centre, 2004a). Similarly, cattle slaughtering operations have also consolidated. Alberta has increased its share of the total Canadian beef processing industry from 40 percent in 1984 to 68 percent in 2000 (Alberta Beef Producers, 2003). Currently, two plants have a majority of Canadian slaughter capacity (4,000 head of cattle/day/plant, almost 3 million head per year). These are Lakeside Packers in Brooks, Alberta, owned by Tyson Foods' subsidiary IBP, and Cargill Foods in High River, Alberta. The latter is owned by Cargill Foods as part of its wholly owned subsidiary Excel Corporation.

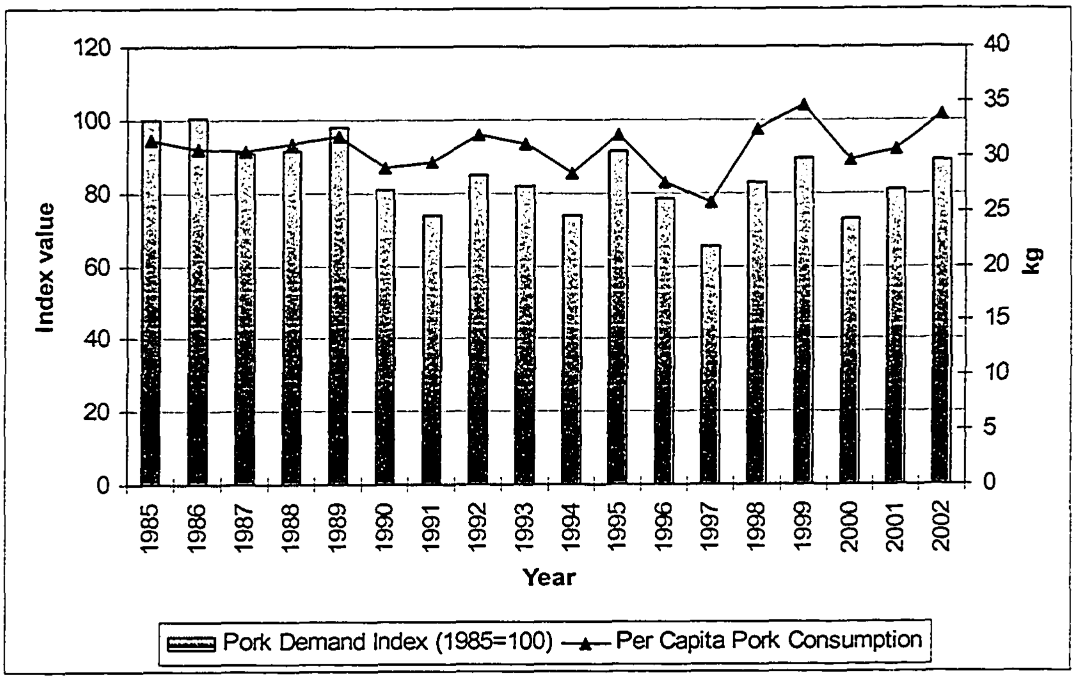
Despite the competitive advantages revealed by its successes in market growth and adjustment in response to technology and cost pressures, the industry faces a number of challenges. Many of these involve economic and social issues. For example, Canadian per capita consumption of beef has declined significantly over the past twenty years, averaging between 38 and 39 kg per year in the early 1980's and between 29 and 30 kg per year in the last couple of years. Meanwhile, total per capita meat consumption taking into account beef, pork and chicken, has been around 90 kg over the whole period. Pork consumption has been relatively constant and chicken per capita consumption has increased more than 90 percent. The reasons for this changing pattern, switching from red meat consumption towards the consumption of other meats such as pork and particularly poultry, are not fully understood. Figures 1-1, 1-2, and 1-3 show demand indexes for beef, pork and chicken in Canada, respectively. These indexes, based on Purcell's beef demand index, show what prices would be if demand had been held constant at base year prices (1985 in this case). For instance, Figure 1-1 shows that in 2002 beef prices were 25 percent lower than they would have been if beef demand had been held constant at 1985 levels. Figure 1-4 illustraie per capita disappearance of the same meats from 1976 to 2001.

Figure 1-1 Beef demand index and per capita consumption, Canada, 1985 - 2002



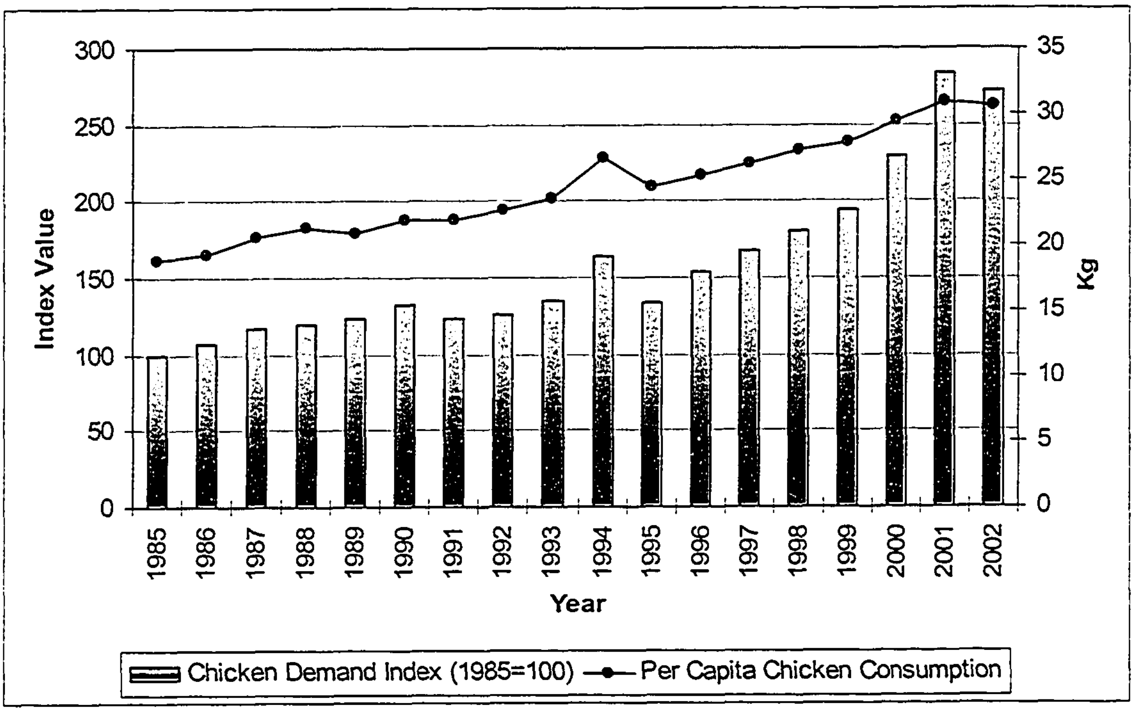

Source: Elaborated with information from Statistics Canada and Agriculture and Agri-Food Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources.

Figure 1-2 Pork demand index and per capita consumption, Canada, 1985 - 2002



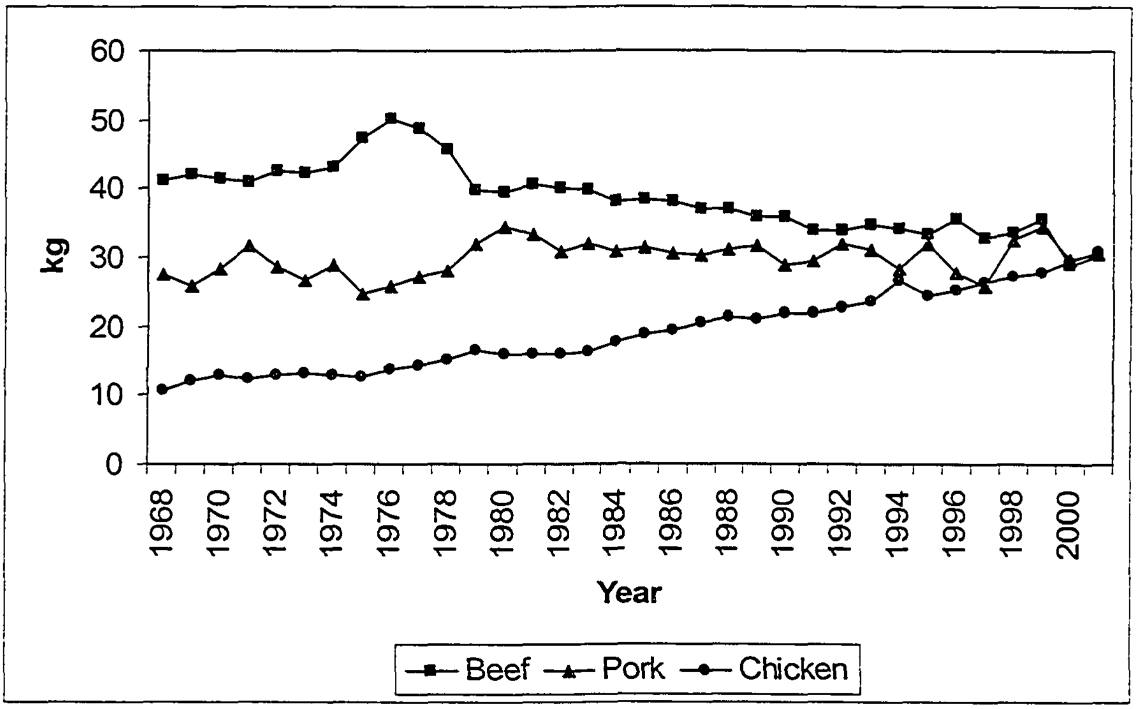

Source: Elaborated with information from Statistics Canada and Agriculture and Agri-Food Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources.

Figure 1-3 Chicken demand index and per capita consumption, Canada, 1985 -2002




Source: Elaborated with information from Statistics Canada and Agriculture and Agri-Food Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources.
* Chicken demand assumed to be own-price unitary elastic

Figure 1-4 Per capita consumption of beef, pork and chicken in Canada (1968-2001)




Source: Elaborated with information from Statistics Canada and Agriculture and Agri-Food Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources.

After the appearance in May 2003 of one cow suffering from BSE in Northern Alberta, the borders were shut to Canadian beef by its main trading partners (including the US, the country that receives most of Canadian beef exports). Taking into account that 60% of beef production is exported, the industry has suffered massively from these measures. Cattle producers and other players in the industry will only be relieved from the enormous economic pressures when trade is fully retaken (i.e. live cattle, bone-in cuts, beef from older cattle) or domestic demand increasingly meets production. The barriers to trade imposed since the discovery of BSE call for an urgent understanding of the factors affecting beef demand in the Canadian market. If the industry is to survive, increased Canadian consumption would permit a larger industry than indicated by current patterns and trends.

World-wide, the beef industry has been affected by the BSE outbreak in England, and isolated cases of this problem in other parts of Europe and Japan. This outbreak caused a collapse in consumption of beef products of around 40 percent in the UK and other European countries such as Germany and Italy (DTZ Pieda Consulting, 1998). This followed the announcement in 1996 of a possible link between BSE and the new variant Creutzfeld-Jakob Disease (nvCJD) made by British officials in the UK. The human disease known as nvCJDt is theorized to have been caused by humans eating bovine material contaminated with BSE. Despite the lack of human health impacts from the recent occurrences of foot and mouth disease in South America (Argentina and Uruguay in 2000) and in Europe (2001), it appears that publicity about this disease outbreak may have contributed to problems of consumer perceptions of healthy beef. Repeated references to E. coli outbreaks in the U.S. (as well as the Walkerton tragedy in Canada) may have raised additional concerns in consumers' minds about the safety of beef consumption. As a partial response to increased concerns about food safety, the Canadian government created in 1997 the Canadian Food Inspection Agency (CFIA). Since then, the CFIA has been the core agency in food safety, working in partnership with Health Canada and Agriculture and Agri-Food Canada. The CFIA has become Canada's federal food safety, animal health and plant protection enforcement agency. With a specialized office on food safety recalls, the Office of Food Safety and Recall, the CFIA has aimed to increase consumer awareness of food safety issues.

Another factor potentially affecting the beef industry is an increase in concerns about eating 'healthier'. Almost nine in ten Canadians (88 percent) consider nutrition important in choosing the food they eat. The last National Institute of Nutrition report on

Tracking Nutrition Trends (2002) states that Canadians expressed increased concerns about saturated fat, cholesterol, vitamins, fibre, sugar, calories, iron, trans-fatty acids and caffeine. White meats may be appealing to consumers as being less fatty, lower in cholesterol and generally a 'healthier product'. Changes in nutrition perceptions, the impact of the recommendations made in "Canada's Food Guide to Healthy Eating" and, in general, increased information on health issues may have contributed to a decline in beef consumption.

Other important factors may also have had an impact on Canadian beef demand. Schroeder (2002a) points out that if the US beef industry had provided products possessing characteristics that consumers wanted, demand for beef in all likelihood would not have declined nearly as much as it did and would undoubtedly be at much higher levels today. Among others, some of those desired characteristics arise from changing consumer demographics and changing health concerns. Consumers are increasingly more interested in how convenient meat products are, especially how quickly such products can be prepared for consumption (Schroeder et al., 2000). Changing lifestyles resulting in decreased time to prepare food items at home requires more convenient products for consumers. There is no doubt about the importance of convenience, food products that have been offered to consumers in more ready to eat ways have seen increased sales; that is the case of fully cooked chicken strips, shredded cheese, and bagged lettuce. Single dish, quick fix meal consumer expenditures expanded 83% in 2002 to US$141 million, the US beef industry has taken this into account and 472 beef products were introduced in the American market in 2001, as compared to only 70 in 1997 (Schroeder, 2002b).

The Canadian industry will face a future challenge from recent legislative changes through the U.S. Farm Bill that will require mandatory country of origin labeling apply to all beef sold in the U.S. Product labels must describe where animals were raised, where they were fed and where they were slaughtered. As a result, this will affect not only exports of meat from Canada, but also exports of live cattle (in the eventual case of fully resumed trade). Tyson Foods, Inc. Chairman John Tyson reported that USDA estimates the cost of country of origin labeling will be almost US$2 billion in the first year alone. Half of the US$2 billion expense will be shouldered by farmers, ranchers and other producers who will be forced to maintain a recordkeeping system to comply with the regulation, while the rest will be borne by retailers and food handlers, such as packers (Tyson Foods Inc. press release, 2002). Mandatory country of origin labeling is a threat to the Canadian industry because it increases handling costs for U.S. retailers, and could cause them to stop selling imported beef.

The industry needs to evaluate the economic potential of a variety of different marketing strategies in response to the actual situation:

- Understanding the factors that determine domestic beef sales and the possible impact of food safety and health issues;
- Exploring the potential of advertising as a strategy to increase sales;
- Estimating the viability of increasing slaughter capacity taking into account that a possible reopening of the borders may harm producer-funded plants if they have to compete against multinational enterprises such as Cargill or Tyson;
- Evaluating the potential of more stringent BSE testing in order to be able to export to markets such as Japan;

- Reducing the dependency of the Canadian beef industry on exports to the US by increasing domestic sales and expanding sales to other markets in the world.

If the industry is to determine which strategy will contribute most to improving cut out values and cattle returns, it is critical that the industry understands the factors currently leading to decreased beef sales in Canada.

**1.2 Economic Problem**

The complexity of the beef market has ramifications from the grassland to the consumer plate. Not only cattle producers, but also processors and retailers, need to understand the phenomena that have led to depressed beef consumption in Canada.

The market expansion enjoyed by cow-calf producers and feedlots throughout the 1990's was due to increased sales, largely maintained by exports. This generated the perception that the industry did not have to be concerned about the domestic market. Foreign demand increases caused the beef industry to expand without noticing the declining tendency in domestic consumption. At a minimum, this trend caused the industry to become increasingly dependent on changes in the export market. Mandatory country of origin labeling made producers start thinking about the incredible dependency of the industry on the American market, and the BSE scare in May, 2003 confirmed that this dependency might cause a complete industry to stop growing or even to shrink, with all the negative repercussions that the loss of part of the producing base could cause. The cattle producer is the most sensitive part of the producing chain. The average cattleman cannot easily change his/her production plans. A severe crisis has caused some producers to lose their herds. In this context, it is vital for the survival of most cow-calf and feedlot operations to promote research in understanding the reasons that have led the Canadian market to decreased beef consumption and to foster additional paths to maintain and eventually expand beef sales such as increasing sales in Canada and diversification of exports.

The processing and retailing sectors are also involved in the problem. Beef sales have traditionally given processors a profitable business that has been very attractive to multinationals and has consolidated into fewer firms. The two most important processors are US based multinationals that do not necessarily depend on Canadian sales to grow or to maintain their businesses, but could potentially benefit themselves from a strong and expanded domestic market. Beef and beef products sales have also been an important share of profits in the case of retailing firms, decreased consumption has reduced that share and it could only be regained with an improved understanding of the Canadian market. Currently, the expansion of domestic beef consumption appears to be one of the most viable solutions for the industry.

Knowing the shape and position of the beef demand curve is fundamental for the cattle/beef industry. Understanding the causal factors leading to decreased consumption of beef and taking them into account in the decision-making process could generate the best strategies to cope with the problem. There are a number of issues that could have influenced the demand for beef in Canada: food safety, health concerns, prices and income, changing consumer demographics, new product development. Determining to what extent each of the mentioned factors has affected beef consumption might contribute to better strategic decisions at the right level of the marketing chain.

If health concerns and food safety issues have had a role in decreased beef demand, producers could launch stronger and more aggressive generic advertising campaigns or could support health information programs that may help to shift the demand curve outwards again. If price is the problem, research in the production process could help to alleviate costs and offer cheaper beef products to consumers, especially in the absence of structural change. If changing consumer demographics or new product development are significantly affecting beef consumption decisions, all the players involved in the industry could invest in developing better, more convenient, and easier-faster-to-eat beef products; such as Maple Leaf Roasts.

**1.3 Research Objectives**

The goal of the research to be undertaken in this project is to determine the impact of factors such as price, expenditure, food safety scares, health information and advertising on beef consumption within Canadian meat aggregate demand. US studies (Schroeder et al., 2000) undertaken regularly have identified the importance of factors such as expenditure or consumer income, food safety recalls, health information and consumer demographics (in terms of women in the workplace etc.), all having statistically significant effects on beef demand. However, the Canadian beef market is somewhat different from the US and although our borders are normally open and prices are determined in North America, trade impediments such as BSE bans or proposed country-of-origin labeling legislation in the U.S makes it imperative that a similar study be conducted for Canada using recent data. The research will provide an assessment of the key drivers associated with changes in per capita consumption of beef in Canada during the past three decades (health issues, food scares, media information including advertising by cattlemen, processors and restaurants, nutritional information provided by governments, doctors, dieticians and social marketing groups, prices, income, etc)

Specifically the research objectives for this study are to:

1. Use time series aggregate consumption data over the period 1975-2001 in order to:

- Quantify the impact of prices and expenditure on demand for meat within Canada.
- Quantify the impact of BSE media coverage, other food safety concerns and health information on demand for meat within Canada.

2. Use expenditure data from Statistics Canada (Family Food Expenditure data, 1992, 1996, 2001) in order to:

- Quantify the impact of prices and expenditures on demand for meat regionally and by age, education, family structure and income categories across Canada.
- Quantify the impact of BSE media coverage, food safety concerns and health information on demand for meat across Canada identifying differences in response by age, education, income, and family structure.

A critical appraisal will be undertaken of the previous literature on the determination of demand for beef/meat in other high income countries including Canada, the United States and European countries. Traditional econometric analysis will be used to estimate the long term impacts of key economic factors on beef consumption, factors such as prices, income, and media information. Similar analysis can be conducted on the survey data provided by Statistics Canada to establish robust estimates of consumer responses to economic stimuli, by region and by demographic characteristics. During the late 1980's and early 1990's examination of meat demand was a relatively common analysis undertaken in Canadian agricultural economics. Since the early 1990's many of the previously publicly available data sets have disappeared. As a result, little analysis of meat demand has been undertaken recently. This becomes particularly critical in an industry that is important economically to Canada and where potential policy changes may significantly affect the international demand for Canadian beef.

# Chapter 2

# Literature Review

## 2.1 Introduction

In order to achieve the objectives outlined in the previous chapter the study of the Canadian meat market requires a deep understanding of the different factors surrounding demand analyses. Determining the impact of prices, expenditure and information variables such as advertising, food safety and health media coverage on Canadian meat demand requires an exploration of consumer theory, different types of analyses (time series versus cross sectional), differences among functional forms, specification of the demand analysis structure (single equations or demand systems), and the impact of information variables on the demand for a specific good or group of goods. The present chapter attempts to thoroughly address these issues so that the rest of this thesis can follow a strong theoretically based structure.

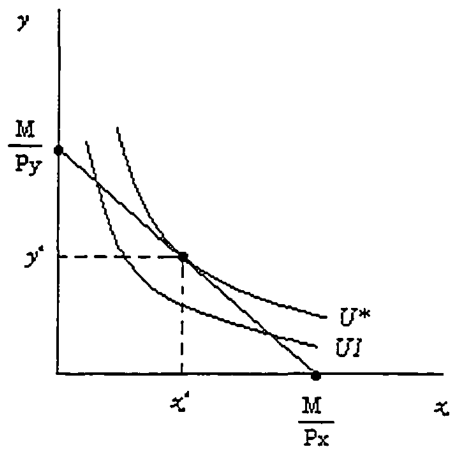
## 2.2 Consumer Theory

Scarcity is the basic concern of consumer decision making, and this concern has to do with the fact that resources are available to the individual in a limited manner. A known and limited budget is used by the consumer to obtain goods at specific prices in order to match a given set of preferences, and such preferences are determined by tastes. In a nutshell, the consumer decision process deals with what goods he/she wants and can acquire with limited income.

Neoclassical consumer theory states a series of axioms on which consumer responses are based. Such axioms (reflexivity, completeness, transitivity, continuity, nonsatiation and convexity, as stated by Deaton and Muelbauer (1980a)), provide a basis for conducting consumer (demand) analysis based on assumptions of rational behavior.

### 2.2.1 Utility maximization (expenditure (cost) minimization)

The consumer then faces a utility maximization problem; get the most out of his/her budget in order to take his/her utility to the maximum possible. That happens precisely when the budget constraint reaches the outmost possible indifference curve. Utility is, as defined by Binger and Hoffman (1998), some measurable level of satisfaction that a consumer gets from consuming a good. If consumers behave rationally, consumer preferences can be represented by utility functions that are convex to the origin (Binger and Hoffman, 1998). Graphically, the utility maximization problem for two goods could be represented as:

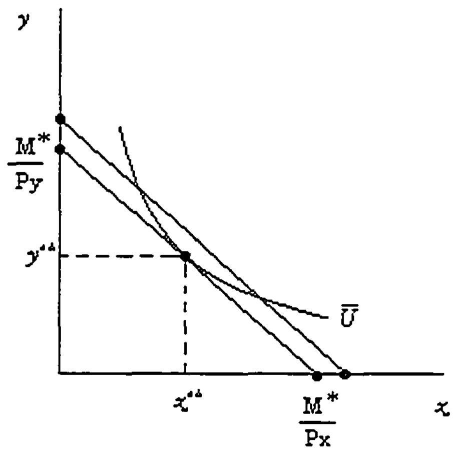



where M is income, Px and Py are prices of the $x$ and $y$ goods, respectively, and $U^*$ and $U1$ are utility functions. Then, the optimal choice $(x^*,y^*)$ occurs at a point of tangency between the budget line and the indifference curve $U^*$ (Binger and Hoffman, 1998). Using the same notation, the consumer's problem of maximizing an objective function subject to the budget constraint can also be represented by:

$$\text{maximize } U = U(x, y)$$

$$\text{subject to: } M \geq PxX + PyY$$

The consumer's problem can also be solved by minimizing cost rather than maximizing utility. This approach minimizes consumer expenditures subject to achieving a specific level of utility. Thus, utility is fixed ($\overline{U}$). Showing this approach graphically, we get:




where M* is income, Px and Py are prices of the $x$ and $y$ goods, respectively, and $\overline{U}$ is the fixed utility function. Thus, the optimal choice ($x^{**}, y^{**}$) occurs at a point of tangency between the budget line $\left(\frac{M^*}{Px} \to \frac{M^*}{Py}\right)$ and the indifference curve $\overline{U}$. Using the same notation, the consumer's problem of minimizing expenditure has an objective function subject to a fixed level of utility that can also be represented by:

$$\text{minimize expenditure} = PxX + PyY$$

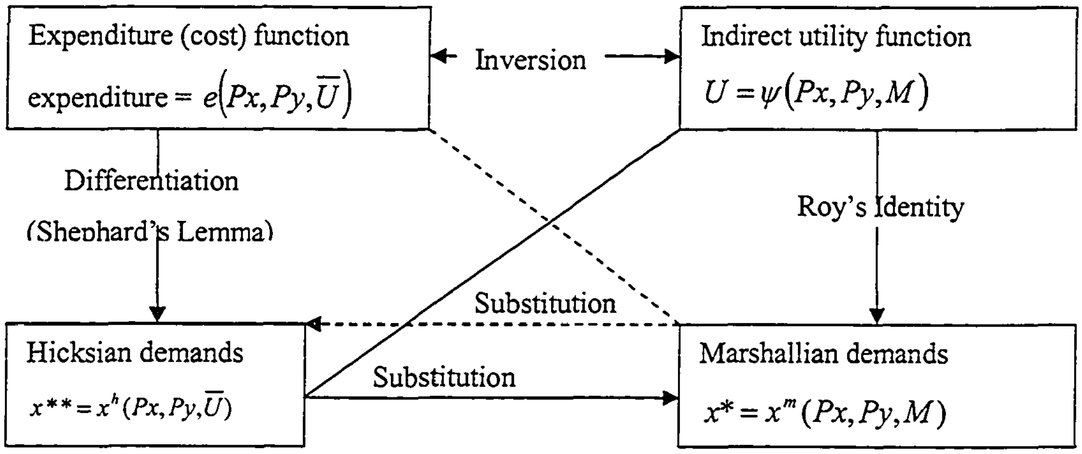
$$\text{subject to: } \overline{U} = U(x, y,)$$

If, from the problems of maximizing utility and minimizing expenditures we have that $M = M^*$, and $U^* = \overline{U}$, then ($x^*, y^*$) = ($x^{**}, y^{**}$). Therefore, the quantity demanded would be the same. This result relies on the concept of duality. Deaton and Muelbauer (1980a) indicate that the cost function and the indirect utility function are intimately related because we can get the indirect utility function ($U=\psi(Px,Py,M)$) by rearranging or inverting the expenditure function (expenditure=$(Px,Py,\overline{U})$) and vice versa. The next figure (based on Deaton and Muelbauer, 1980a) summarizes the relationship between the original and the dual problems.

| | | |
|---|---|---|
| Constrained utility maximization:<br>maximize $U=U(x,y)$<br>subject to: $M \geq PxX+PyY$ | Duality<br>↔ | Constrained expenditure minimization:<br>min expenditure = $PxX+PyY$<br>subject to: $\overline{U}=U(x,y,)$ |
| ↓ | | ↓ |
| Solve first order condition<br>Marshallian demands:<br>$x^*=x^m(Px,Py,M)$ | | Solve first order condition<br>Hicksian demands:<br>$x^{**}=x^h(Px,Py,\overline{U})$ |
| ↓ | | ↓ |
| Substitute into the original<br>objective function to yield:<br>The indirect utility function<br>$U=\psi(Px,Py,M)$ | ↔<br>Inversion | Substitute into the original<br>objective function to yield:<br>Expenditure (cost) function<br>expenditure = $e(Px,Py,\overline{U})$ |

Deaton and Muellbauer (1980a) summarize: differentiating the expenditure (cost) function (using Shephard's Lemma) we can get the Hicksian demands, inverting the expenditure (cost) function we attain the indirect utility function, and substituting the indirect utility function into the Hicksian demands we obtain the Marshallian demands. As well, through Roy's Identity, we can obtain the Marshallian demands from the indirect utility function, and substituting the expenditure (cost) function into the

Marshallian demands we obtain the Hicksian demands. With all these relationships, empirical estimation is greatly simplified, estimating any of the two functions (indirect utility or expenditure (cost)) allows the underlying demand functions (Marshallian or Hicksian) to be derived and identified fairly rapidly. The next figure summarizes these relationships:

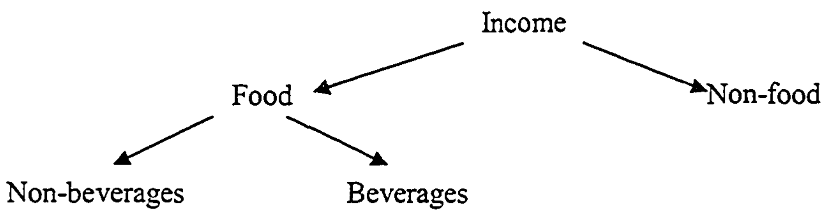



Deaton and Muellbauer (1980a)

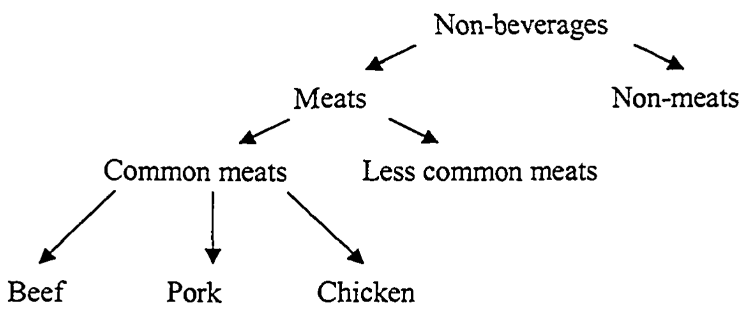
### 2.2.2 Weak Separability and Utility Trees

As much as one might wish to do so, it is not possible to estimate a demand system including each and every single commodity. This is the logic behind the development of the concept of separability attributed to Leontief (1947) and Sono (1961), concept widely applied nowadays to demand analysis in order to focus the empirical efforts to a determined group of closely related goods (generally). Green (1976) indicates that weak separability is that a group of commodities is weakly separable if and only if the marginal rates of substitution between any two commodities in the group is independent of the quantity of any commodity outside the group. Weak separability, as indicated by Deaton and Muellbauer (1980a), implies that a group of goods can be separated from the rest of the consumption commodities, so that preferences within groups can be described independently of the quantities in other groups. That is, we can have broad groups of consumption goods which are independent from one another (say food from non-food commodities). Then, each group can be subdivided to generate subgroups, which implies that we can have subutility functions for each group and that the values of each of these subutilities combine to give total utility (Deaton and Muellbauer, 1980a).

The disaggregation of the possible commodity groups and subgroups can lead us to the formation of a utility tree. For the case of this thesis one possible utility tree could be the next:




Non-beverages could be disaggregated even more into meats and non-meats, by doing so we can continue creating our utility tree as follows:




The above utility tree is just one of many possible combinations. While there are potentially several meat products (e.g. turkey, lamb, veal) that could be included as common meats, the analysis of this thesis considers only the three most important meats in the Canadian diet, beef, pork and chicken. Fortunately, these are also the meats for which data are most readily available.

## 2.3 Meat Demand

### 2.3.1 Time Series vs. Cross Sectional Analysis

Time series analyses allow us to identify consumption trends over time for a specific commodity, while cross-sectional models detect similarities or differences across individuals at a moment in time. Most meat demand analyses in North America have been time series studies, with only a few having attempted to explore the use of microdata to examine factors affecting meat demand. The use of aggregate data may have been favored by the fact that few sources of cross-sectional information were available. Currently, increased availability of microdata has led to more cross-sectional studies on meat demand in the US, but there has not been a cross-sectional study considering the impact of socioeconomic and demographic variables on the demand for meat in Canada.

Temporal analyses can provide general insights on the demand for the various individual meats as a whole. Price and income elasticities are often derived from these studies, and information variables can be incorporated in a number of ways in order to determine to what extent information has impacted meat consumption. This kind of study also provides a better understanding of the demand for a specific commodity through time. That is, longitudinal studies detect trends and conclude whether such trends are significant and if they are positive or negative. With time series analyses it is also possible to take into account seasonal impacts on demand. Stated by Chung and Kaiser (2002), the most compelling justification of this approach is that data are mainly available in aggregate form, and modeling with this data is analytically simpler, more convenient, and more affordable.

With the increased possibility of obtaining cross-sectional data from public agencies or private businesses, spatial studies have been receiving increased attention, and this augmented appreciation for cross-sectional data and studies goes back to what Manchester (1977) realized a long time ago: demand analyses based on time series data are unsatisfactory because aggregate data usually mask many changes in the groups that comprise the whole. Chung and Kaiser (2002) remind us that a number of studies indicate that time series modeling may provide misleading conclusions since the approach ignores the heterogeneity of individual behaviour. Cross-sectional studies also allow us to take into account impacts for the demand function related to the socioeconomic and demographic characteristics of the population being studied.

Most meat demand studies on the impact of traditional and information variables have focused on time series analyses and have assumed the existence of a representative agent from which general conclusions can be drawn. Chung and Kaiser (2002) point out the existence of a vast literature indicating possible misleading conclusions that aggregate time series modeling can provide because of its neglect of consumer heterogeneity. In their application to the American milk market, they find that their micro and macro models provide different results when it comes to the sign and magnitude of their estimates. Interestingly, an information variable (advertising) impacts differently (direction of the impact) depending on the model used. Therefore, the potential differences between time series and cross-sectional estimates when using information variables, supports the idea of comparing such models in order to obtain conclusive estimates of the impact of media information on Canadian meat demand. There is no question about the importance of getting robust estimates. More than ever the meat industry has been impacted by food safety concerns that can only be properly addressed if the evidence is strong enough to be taken as the platform on which to make correct policy decisions.

### 2.3.2 Different Functional Forms

It is not easy to decide which functional form to use since there are many different possibilities, and sometimes the final decision as to what functional form to use depends more on researcher preference and ease of handling than on a formal theoretically grounded process. Meat demand analyses have been done using a number of different functional forms. Lately, most studies have utilized somewhat flexible functional forms, examples of which are the AIDS with some of its variants (e.g. Chalfant, Gray and White, 1991; Reynolds and Goddard, 1991; Chen and Veeman, 1991; Eales, 1996; Patterson and Flake, 1999), and the Translog (e.g. Yen and Chung, 2002). The Rotterdam functional form has also been used (e.g. Brester and Schroeder, 1995; Kinnucan et al., 1997), but it is not considered to be a flexible functional form.

The use of flexible functional forms for time series analysis is recommended by Pollak and Wales (1992). As they state, these functional forms provide sufficient price variation for estimating the cross price effects that flexible functional forms are designed to model. They also state that a demand system is said to be flexible when it is capable of providing a second order approximation to the behaviour of any theoretically plausible demand system at a point in the price-expenditure space. The main feature of flexible functional forms is that they do not impose a priori restrictions on the elasticities associated with them other than the theoretical restrictions (e.g. the Cobb-Douglas restricts the elasticity of substitution and the expenditure elasticities to be one).

In discussing the advantages and limitations of flexible functional forms, Pollak and Wales (1992) point out that even though the problem of modeling price effects has not been solved by the development of flexible functional forms, it constitutes an important expansion of the menu of specifications available for empirical research. One of the possible disadvantages of these functional forms is the number of parameters, especially when there are a large number of goods considered in a given demand system. But they also point out that when the number of goods is small, when the data offer extensive variation in prices and expenditure and degrees of freedom are not a problem, it is not unreasonable to consider the use of flexible specifications which include additional parameters and, thus, allow more flexibility in capturing expenditure and own-price effects.

This thesis considers, in its time series analysis section, three commodities: beef, pork and chicken. As well, the available data are from a reasonably long time series. Based on the recommendations drawn from Pollak and Wales (1992), it would be reasonable to use a flexible functional form. In the case of the cross-sectional analysis, an attempt is made to use a flexible functional form, in order to attempt to capture more flexible responses to changes in expenditure, at least for the analysis of household budget data (Pollak and Wales 1992). Their view is that, household budget data offer greater scope for estimating expenditure effects and should be analyzed using functional forms capable of reflecting them.

### 2.3.3 Demand Systems vs. Single Equations

It was not until the 1980's that the computing power to facilitate the estimation of demand systems widely existed. Besides, the theory has been evolving to provide more comprehensive models that are closer to reality and allow for enhanced theoretical structures. Both the increased availability of computers and theoretical achievements have played an important role when doing empirical analysis, and facilitated enormously the empirical estimation task.

It is because of the closeness to reality that the research in this thesis is based on a demand system over a single equation model. A demand system allows for the satisfaction of the constraint that goods expenditure shares are less than or equal to income, a constraint that is not satisfied by single equation models. As well, it has been pointed out that the use of demand systems has some advantages over single equations: statistical efficiency, consistent measures of cross-advertising (-information) effects and theoretical consistency (Alston, Chalfant and Piggott, 2000). The three advantages mentioned above are assets in the empirical estimation of this thesis.

### 2.3.4 How to Include Information Variables in Demand Systems?

The assumption of perfect information and unchanging tastes in consumer theory rules out the impact on consumer decision-making of advertising or other information variables such as those related to health or food safety. Nevertheless, the assumption of complete knowledge about the attributes of the goods and services that the consumer acquires is not a realistic one in the short run. Consumer knowledge imperfection caused by the never-ending flow of updated or new information opens the possibility for an impact of such flow on consumer behaviour. The imperfect information status of consumers in the short run can be partially reduced by the acquisition of more information. As stated by Teisl, Bockstael, and Levy (2001), increased or better information may allow individuals to increase their utility from consuming goods and services. Ippolito and Mathios (1990) suggest that consumer welfare is primarily determined by the flow of information in a rapidly changing market.

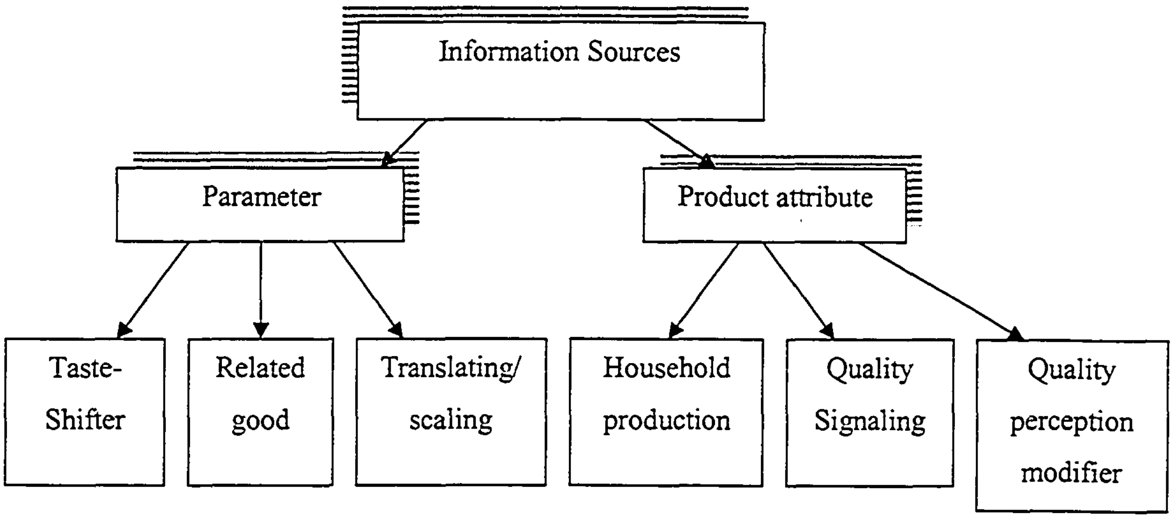
Information is hard to measure in order to be taken into account in empirical studies. And this difficulty has been clearly highlighted by the fact that not too many studies on the impact of information variables have been carried out. Information sources either in the form of advertising (generic, brand, and restaurant), health advice, food safety recommendation or social marketing encouragement could potentially impact the position (shift), slope or shape of the demand function (Goddard, Griffith, and Quilkey 1992). Some of the already known ways to introduce information variables in demand studies are industry expenditures in the case of advertising and media coverage in the case of food safety or health information. However, there are different opinions about the proper way to include information in the consumer utility maximization problem, and various approaches have been proposed.

The question as how to incorporate information variables in the consumer utility maximization problem remains open. It is not the purpose of this thesis to resolve such problems, but it is worth noting what the different opinions on this topic are. It has been suggested that information variables, specifically advertising should be included in the utility function as a taste shifter (Dixit and Norman, 1978), but it also has been argued that some variables (including time) could be included into the indirect utility function as an argument (Christensen, Jorgenson, and Lau, 1975). Both approaches have pros and cons, some studies (e.g. Dixit and Norman, 1978; Goddard, Griffith, and Quilkey, 1992) have pointed out the problem with the shifter approach stating that consumer welfare measures are not in the same scale before and after advertising has occurred. Meanwhile, the inclusion of advertising as an argument in the utility function has been signaled by Fisher and McGowan (1979) to have the issue of directly contributing to consumer utility. There is even an opinion totally opposed to the inclusion of advertising in the utility function, arguing that such inclusion has no impact on the explanation of the consumer decision making process (Kotowitz and Mathewson, 1979).

Goddard et al. (2004) point out the possible different approaches when incorporating information variables in the consumer utility maximization problem. From their review of various analyses, they indicate that these studies can be broadly grouped into two major theoretical categories to modeling the effects of information on consumer demand for a good. Such categories are information as an exogenous variable and information as a quality modifier.

Under the first category, information sources are variables in the utility function and such variables, depending if positive or negative, increase or decrease the sales of the specific related good by changing consumer taste. The quality approach suggests that information intensity signals the quality of the product, also causing an impact on purchases through the information function. Each one of these categories comprises three sub-categories; taste shifter (Basmann 1956; Dixit and Norman 1978; Goddard 1988), related good (Becker and Murphy 1993), and translating/scaling (Pollak and Wales 1981) in the case of exogenous variables and household production (Stigler and Becker 1977), quality signaling (Milgrom and Roberts 1986; Nelson 1974) and quality perception modifier (Kotowitz and Mathewson 1979b) when talking about product attributes.

Figure 2-1 Approaches to incorporating information sources into the consumer utility maximization problem




Goddard et al. (2004)

## 2.4 The Effect of Information on Meat Demand

### 2.4.1 Creation of Information Indices (News Indices)

As stated in a previous section of this chapter, the assumption of perfect information and unchanging tastes in consumer theory rules out the possibility of advertising or other information variables such as that related to health or food safety to have an impact on the consumer decision-making process. Yet, in the short run, information can play a role in changing consumer perceptions because of the continuous flow of new information. At this point in time food safety and health information may be able to have a substantial impact on the demand for the various meats in Canada. Thus, this thesis tests the hypothesis that food safety and health information have impacted consumer choices with respect to beef, pork and chicken consumption.

Before the use of information indices became a recognized tool to measure the impact of health or food safety information on the demand for a specific food item, demand analyses identifying structural changes in meat consumption were believed to be associated with health awareness, especially by concerns associating diet cholesterol and meat (Braschler, 1983; Moschini and Meilke, 1984; Chen and Veeman, 1991). Some other studies did not find a structural shift (Chalfant and Alston, 1988; Robenstein and Thurman, 1996). None of the above studies explicitly included an information index, to measure the impact of health information on the demand for meat.

Some indices not related to media coverage have been included in demand analyses to account for the impact of health consciousness and food safety information on food consumption. After it was recognized that there was a link between egg consumption and diet cholesterol awareness (Brown and Schrader, 1990), Flake and Patterson (1999) included data on per capita egg consumption as a health information variable to account for cholesterol awareness in a meat demand study. Similarly, meat demand modeling was carried out using the ratio of consumption of low fat milk to whole milk as a proxy for consumer concerns on the link between fat and cholesterol consumption and heart disease (Gao and Shonkwiler, 1993). Government recalls have also been modeled in food demand analysis; Schroeder, Marsh and Mintert (2000) used the number of Food Safety Information Service recalls to account for the impact of food safety on beef demand.

Previous studies have used different methods to explicitly account for health and food safety information variables and then measure their impact on the demand for a specific good. Brown and Schrader (B&S) (1990) created a cholesterol information index in order to measure to what degree health information had impacted egg consumption in the US. Their index takes into account the number of articles published in medical journals dealing with cholesterol from 1966 to 1987, and differentiates between articles linking and not linking diet cholesterol, serum cholesterol and heart disease or arteriosclerosis. The index is finally constructed by summing the articles supporting a link between cholesterol and arterial disease and subtracting the sum of articles questioning such links. They lagged their index two periods. Using the same cholesterol index, Capps and Schmits (1991) explored the impact of such index on the demand for various meats (beef, pork, poultry and fish) in the US. With the objective of measuring the impact of cholesterol awareness on butter consumption in Canada, Chang and Kinnucan (1991) constructed their cholesterol index by extending the Brown and Schrader (B&S) index. They added medical articles published in Canada so that they could get an index relevant for this country. Then they developed what they called an "effective negative publicity" measure using a weighting procedure. Dealing with the demand for fats and oils in the US, Chern, Loehman and Yen (1995) also included a cholesterol index in their analysis to find out how the demand for these products had been affected by health information. Using a Bayesian approach to take into account health information, their index also included medical journal articles and was based on the B&S index. Updating the B&S index and following the Chang and Kinnucan (1991) weighting procedure, Kinnucan et al. (1997) looked at the impact of health information on the demand for meat in the US. Kim and Chern (1999) explored alternative measures of health information and the demand for fats and oils in Japan. Based on the B&S index and using the Kim and Chern (1997) approach they constructed three different indices. For the first index, which is just a cumulative count, they only used more keywords (i.e. diet and fat in addition to cholesterol and heart disease). The second index is based on a weighting function, specifying the duration of the article's perceived impact and a time period for the maximum impact to occur (based on Chern and Zuo, 1995). Finally, the third index is based on a geometrically declining lag structure (based on Kim and Chern, 1997).

The rationale for the use of medical journals to create information indices is that health practitioners will pass along to consumers the information that they receive through scholarly publications. Medical journal articles are then considered primary information that can also be diffused by other means; newspapers, magazines, TV, and patients who already received medical advice from their physicians. Therefore, primary information (medical journal articles) is passed along to consumers through secondary sources of information (medical advice, mass media coverage, and word of mouth). Although the B&S approach is considered a major breakthrough in measuring a non-economic preference variable and incorporating it into food demand analysis (Moon and Ward, 1999), the linkage between scholarly publications and what is actually published in the media has been questioned. In a study conducted by Barlett, Sterne and Egger (2002), in which they reviewed scholarly articles from two British journals and reporting articles from two British newspapers, they found that only 81 out of 1193 (7 percent) medical articles received newspaper coverage. Houn et al. (1995) examined scientific journal articles and newspapers and magazines stories about the association between alcohol and breast cancer. They found that the press cited only 19 percent of the medical articles published during the study period. Moreover, 77 percent of the stories were based on as few as three research studies.

Barton et al. (1997) state, based on various studies, that mass media are the principal sources of nutrition information for most Canadians and that the newspaper is among the most frequently used out of those sources. In their study, they surveyed newspaper subscribers in order to determine the use of nutrition information found in a newspaper (Hamilton Spectator), and found that 75 percent of respondents reported reading health and nutrition information. As well, 90 percent of the health and nutrition information readers discussed the health column with others and 46 percent used such information to reinforce changes in dietary behaviour. Therefore, based on the fact that not all the medical articles make it to the mass media and that consumers are more likely to be reached and influenced by newspaper stories, it makes sense to use newspaper articles to create information indices in order to include them in demand analysis and capture the public response to a specific food-related issue.

Media coverage on health information impacts food demand. Dodd and Morse (1994) estimate that the *60 Minutes* segment on the French Paradox had a positive impact on wine sales, increasing red wine sales by 44.5 percent during the 4-week period after the program was aired. Dodd and Morse (1994) also point out two more situations where mass media coverage affected food consumption. In 1989, after a *60 Minutes* program highlighted the link between a chemical used in apple production and cancer, apple sales fell almost immediately by about one third. Conversely, a book linking oat consumption with cholesterol reduction caused oat bran cereals to increase its share in the ready-to-eat cereal market from 2.7 percent to 18.7 percent in just two years (from 1987 to 1989).

Some studies have included indices constructed from newspapers in demand analyses. Burton and Young (1996), trying to unscramble the impact of BSE awareness on beef, pork, lamb and poultry in the UK, used an index based on the number of newspaper articles published that mentioned BSE. They used the index in two ways; the first is the number of articles per quarter (may cause transitory shifts) and the second is a cumulative count (long-run impact). No difference was made between positive and negative articles. Strak (1998) also used press reports to create a meat scares index and looked at the impact of his meat scares index on beef, pork, lamb and poultry sales in the UK. Flake and Patterson (1999) created a food safety information index by counting the number of articles filed by a news organization (Associated Press) on E. coli, and salmonellosis contamination in beef and BSE. They differentiated between positive and negative articles, and created their index by subtracting the positive articles from the negative articles. Nivens and Schroeder (2000) created an index based on newspaper articles and used net counts (negative minus positive) to investigate the impact of BSE media coverage on beef consumption. Also looking at the impact of BSE, but this time interested in price changes through the marketing chain, Lloyd et al. (2001) used a food publicity index that took into account the number of articles relating to food safety in the British broad-sheet press. Dyack (2002) developed wine health information indices based on newspaper articles; departing from the standard approach of net counts, she constructed various health indicators. Examples of them are, among others, article counts (number of total, number of positive, number of negative, number of balanced, number of positive minus number of negative, number of positive divided by the sum of number of positive plus number of negative), various accumulation periods (monthly, 3-month rolling sum, 6-month rolling sum, 12-month rolling sum), and scores. In total, she identifies more than fifty variations of media indices, but for her demand analysis she used a scoring system that measured the degree to which information change in each month was relatively encouraging or discouraging when compared to neutral information. Verbeke and Ward (2001) also used a media index to investigate the impact of food safety information on fresh meat consumption in Belgium, but it was constructed based on the number of TV news reports about meat safety issues. Their index is built by subtracting the number of positive TV reports from the number of negative reports. In order to capture the cumulative effect of information given in TV reports, they specified a five-period distributed lag, extending the total response interval to a 6-month period for negative reports, and used a weighting procedure.

Some other approaches dealing with the impact of health awareness on food have been tried. Survey data have been used to disentangle the possible effects of specific health information on food demand. Variyam, Blaylock and Smallwood (1996) investigated the relationship between fiber-specific information and dietary fiber intake, taking into account various demographic characteristics of US household meal planners. In order to measure information, they used some fiber-related Diet and Health Knowledge Survey (DHKS) questions (1989 and 1990 surveys), which measure three dimensions of fiber information: sources of dietary fiber, awareness of health problems caused by insufficient fiber intake and attitude toward consuming foods rich in fiber. Nayga (1997), based also on the DHKS survey but from 1991, attempted to shed light on the relationship between socio-demographic factors and how people perceived the importance of nutrition in food shopping. The dependent variable was a discrete rating scale valuing the importance of nutrition in food shopping. Verbeke, Viaene and Guiot (1999) based their findings on a consumer survey conducted in Belgium in 1998. The aim was to get insights about the decision-making process related to fresh meat, when consumers are bombarded with alarming mass media meat-health reports. With the use of some binomial variables, their survey dealt with claimed behaviour and behavioural intentions, attitude to mass media meat-health information and meat-health beliefs, health concerns related to meat consumption and meat attribute perception. Moon and Ward (1999) included a health concern index in their analysis about US meat consumption. The index was derived from the degree of concern households expressed about fats and cholesterol, and was obtained from the NPD group database on consumer attitudes, demographics, and consumer practices.

It has been argued that mass media information has some problems, and that its reliability, when it comes to the objective reporting of health issues, is doubtful. Bartlett, Sterne and Egger (2002), referring to some other studies, state that newspapers' reporting of health issues has been criticized for attributing too much certainty to research findings, for the premature representation of findings as breakthroughs, and for being alarmist, incomplete, or inaccurate. Yet, the main objective of this thesis is not the accurateness of media reports on health but their actual impact on consumer behaviour with respect to meat consumption. Whether they are right or not, they do have an impact on the public. Based on the fact that the newspaper is one of the most frequently used sources of nutrition information (Barton et al., 1997), the indices used in the present study are derived from newspaper articles published in Canada and have to do with both food safety and health concerns.

### 2.4.2 Health and Meat Consumption

#### 2.4.2.1 Is It True that Red Meats are Bad for One's Health?

The public belief that white meats are better for one's health might have impacted meat consumption choices; causing increased consumption of poultry and fish products and reduced intake of beef and/or pork. The reasons for the reduction of red meat in the human diet date back to the mid-late 1970's and early 1980's, when medical research results started associating increased consumption of red meats with various diseases.

#### 2.4.2.2 Health Risk from Meat

Scientific evidence showed that significant risks for beef, lamb, and a combined group of highly saturated fat foods consumption were associated with colon cancer. However, the evidence linking diet to breast cancer was less clear (Phillips, 1975). In a different study, breast cancer mortality was positively associated with demand for total calories, protein, fat, beef, and table fats (butter and margarine) (Gaskill et al., 1979). In a literature review concerning international correlations between dietary items and cancer frequency, the data on cancer mortality and food consumption showed strong and consistent correlations between death rates of cancers of the colon and breast and the per capita consumption of total fat and nutrients derived from animal sources, especially beef, pork, eggs, and milk. Similar but less consistent correlations have been reported with cancers of the prostate, ovary, and endometrium. Epidemiological data are consistent with the hypothesis that excessive beef and low vegetable consumption are causally related to colon cancer. These food items probably do not have a direct carcinogenic role but rather provide a microenvironment favorable to the actions of carcinogens (Correa, 1981). A Canadian study developed in Northern Alberta which associated diet and breast cancer, found significant increasing trends of relative risks with more frequent consumption of beef, pork and sweet desserts (Lubin et al., 1981). Other studies have also associated consumption of red meats with various types of cancer (Nagai et al., 1982; Miller, 1982; Manousos et al., 1983; Miller et al., 1983; Hislop et al., 1986). Medical research has suggested diets that aim to decrease total fat intake or that pretend to reduce cholesterol levels because of their relationship with coronary heart disease in both men and women. Among other food items, they suggest the reduction in beef intake (Sharlin et al., 1992). Some have recommended the increase of fish and poultry products and decrease of beef and pork in order to reduce intake of dietary cholesterol and saturated fatty acids, and to increase polyunsaturated fatty acids (Gorder et al., 1986)

#### 2.4.2.3 Health Benefits from Meat

Positive health attributes of meat, especially red meat, have been less popular. Nevertheless, evidence from as early as 1975 appears to contradict the hypothesis that beef and fat consumption are involved in the etiology of colorectal cancer (Enstrom, 1975). It was also found that there was no increase in risk of colon or rectum cancer regardless of the amount of beef or other meats ingested (Graham et al., 1978). Eynard and Lopez (2003) suggest that in spite of the considerable amount of research about the consumption of red meat, total fats, saturated/unsaturated fatty acids and cholesterol, the issue remains controversial. Recent results about meat intake and risk for colorectal cancer have shown an unexpected dual behaviour related to the type of meats. Fatty meat derivatives, such as cold cuts and sausages, mainly prepared from fatty beef (up to 37% fat) are associated with higher risk, whereas high consumption of lean beef (<15% fat) behaved as a protective dietary habit. More recent studies do not support previous findings of an association between either meat or fat and colorectal cancer incidence (Flood et al., 2003) or that meat or saturated fat intakes are related to pancreatic cancer risk (Michaud, 2003). Stomach cancer research found positive associations for bacon and other sliced cold meat but not for smoked sausage, total cold meats, rashers/bacon, boiled ham and smoke beef/pork loin roll (van den Brandt, Botterweck, Goldbohm, 2003).

Dewhurst et al. (2003) state that the declining consumption of ruminant products has been partly associated with their high proportion (but not necessarily content) of saturated fatty acids. Recent studies have focused on the less prominent fact that they are also important sources of beneficial fatty acids, including n-3 fatty acids and conjugated linoleic acids. This is particularly important if we consider that total intake of n-3 polyunsaturated fatty acids was associated with reduced risk of Alzheimer disease (Morries et al., 2003). So, dietary intake of n-3 fatty acids may reduce the risk of Alzheimer disease incidence. Even though seafood is the main source of n-3 fatty acids, meat was found to be the second contributor of n-3 fatty acids in the Australian population (Meyer et al., 2003). The general recommendation is a reduction of red meat intake but beef together with whole milk and other dairy derivatives are almost the only sources for conjugated linoleic acid family, which are recognized by the National Academy of Sciences of the US as exhibiting consistent anti-tumor properties, the beneficial effects of minor amounts of conjugated linoleic acid may be relatively enhanced in lean meat compared to fatty meat sub-products which contain a substantial amount of saturated fatty acids and cholesterol, as in cold cuts and cow viscera (Eynard and Lopez, 2003).

The argument for keeping red meats in the human diet refers to iron and zinc intake. Low iron intake has been associated with vegetarianism. Iron and zinc are currently the trace minerals of greatest concern when considering the nutritional value of vegetarian diets. The absorption of both iron and zinc is lower with vegetarian than with nonvegetarian diets (Hunt, 2003). Risk of poor iron status may be reduced by consuming lean red meat. Consumption of lean red meat has been suggested as a reducing factor of risk of poor iron status (Thane, Bates and Prentice, 2003). Special groups, such as menstruating women or women that were pregnant during the last 12 months are at greater risk of iron deficiency and the consumption of smaller portions of red meat, chicken and fish was related to low iron status (Wolmarans et al., 2003). A different study (Gibson and Ashwell, 2003) found that women who ate least meat had three times the risk of a low iron intake compared with consumers of red and processed meat.

A prudent omnivorous diet with moderate amounts of animal products (including red meat) together with the consumption of ample amounts of vegetables is thought to be just as protective as a vegetarian diet. On the other hand, the omission of meat and fish from the diet increases the risk of nutritional deficiencies. A vegan diet, in particular, leads to a strongly increased risk of deficiencies in vitamin B12, vitamin B2 and several minerals such as calcium, iron and zinc. However, even a lacto-vegetarian diet produces an increased risk of deficiencies of vitamin B12 and possibly certain minerals, such as iron (Dagnalie, 2003).

With respect to the combination of different meats in the diet, conflicting recommendations are prevalent regarding the appropriateness of red meat versus white meat consumption for individuals aiming to reduce body weight and cardiovascular disease risk. A study comparing weight controlling programs (Melanson et al., 2003) found that weight loss was similar between the beef-consumption and the chicken-consumption groups. Both groups showed significant reductions in body fat percentage and total and low-density lipoprotein cholesterol, with no significant differences between groups. They concluded that weight loss and improved lipid profile can be accomplished through diet and exercise, whether the dietary protein source is lean beef or chicken.

At the end, the issue is one of better-balanced fat-reduced diets that do not necessarily rule out usage of red meats but that ensure a proper intake of essential nutrients (i.e. iron and zinc) and give people the opportunity of continuing to consume practically all the food items that they like.

### 2.4.3 Meat Demand and Health

Consumption of meat products has undergone considerable change in recent years. The most common feature of this change has been due to the switch away from red meat consumption towards the consumption of other meats such as pork and particularly poultry which has appealed to consumers as being less fatty, lower in cholesterol and generally a ‘healthier product’ (Lloyd et al., 2001).

Experiences with other food products, i.e. apples and oat brand, have shown that media coverage can have a substantial impact on food consumption. Health issues, particularly when they relate to cancer and heart disease, can quickly change consumer attitudes to food products (Dodd and Morse, 1994).

Verbeke et al. (2000) in their study of the impact of health communication on meat in Belgium concluded that attention to mass media coverage has a highly negative influence on consumer behavior and decision-making toward consuming fresh meat. Consumers exposed to mass media coverage during the decision-making process about meat consumption reported an impact on their final decision in both the past and in the near future. Those consumers also reported high health consciousness.

With respect to the specific impact of health information on meat demand, Flake and Patterson (1999) reported that a health information proxy had a negative impact on beef consumption. Increased consumer information on cholesterol was seen to result in a decline in beef consumption. The beef cholesterol information index elasticity was estimated at -0.063.

A study carried out by Moon and Ward (1999) measuring the impact on meat demand of a health index derived from the degree of concern households have about fats and cholesterol, found those concerns to have negative and statistically significant effects on beef and pork, whereas having positive and statistically significant effects on chicken, turkey and fish. The findings suggest that the white meat and fish industries have benefited from health concerns about red meat.

### 2.4.4 What is Food Safety?

Food safety occurs when all kinds of contaminant agents, occurring naturally or as a consequence of inadequate production processes, are kept away from food throughout the food production chain, assuring consumers a safe food supply that does not cause immediate illness or increase their risk of chronic disease.

Canada is known for its safe and high-quality food supply. In order to maintain this status, Health Canada bases its food safety policies in three fundamental principles: the health of Canadians is paramount, policy decisions are grounded on scientific evidence, and all sectors and jurisdictions collaborate to protect consumers. According to its website on food safety, Health Canada establishes policies and standards governing the safety and nutritional quality of all food sold in Canada, and carries out food-borne disease surveillance for early detection and warning. Enhanced public health surveillance systems are in place at all times to provide immediate information on outbreaks of food-borne illnesses. Health Canada's policies and standards are enforced by the Canadian Food Inspection Agency (CFIA). With respect to meat safety, the CFIA conducts the meat hygiene program which ensures that meat and poultry products leaving federally-inspected establishments for interprovincial and export trade or being imported into Canada are safe and wholesome.

#### 2.4.4.1 Bovine Spongiform Encephalopathy

BSE is classified as a Transmissible Spongiform Encephalopathy (TSE) and there is no cure. It is commonly thought that BSE is spread by feeding processed remains of sick animals to healthy animals that contract the disease from feed. There have been some opinions about the spontaneous appearance of BSE, as is the case of sporadic Creutzfeldt-Jakob Disease (sCJD), but so far there has not been scientific proof of this. However, some findings from Italy (Casalone et al., 2004) and France (Biacabe et al., 2004) raise the possibility of spontaneous cases of mad cow disease with no infectious origin (Johnston, 2004).

There are TSEs that can occur in other mammals. Humans can suffer from Fatal Familial Insomnia, Cerstmann-Straussler Syndrome and Creutzfeldt-Jakob Disease (CJD). NvCJD or vCJD is the related human disease that is theorized to have been caused by humans eating bovine material contaminated with BSE. In 1995/96, the first death occurred of a person with nvCJD. In 1996, officials in the EU and UK announced that there was a potential link between BSE and nvCJD.

At the peak of the epidemic in 1992, 36,000 cases of Bovine Spongiform Encephalopathy (BSE) were reported in Great Britain compared with 1,348 in 2000. Until February 2001, BSE had not occurred outside the EU, and since BSE was first diagnosed in the UK in 1986, there had been 180,903 BSE cases reported in the UK and 1,924 elsewhere in the EU.

In September 2001, a 5-year old cow was diagnosed with BSE in Japan. The finding led Japanese authorities to make BSE testing mandatory in every single animal slaughtered, starting on October 18$^{th}$, 2001, an action that some market players considered a non-tariff trade barrier and a protectionist move. In less than three months, there was reported a second case of BSE in the largest Asiatic beef importer. Some media reports indicated a decrease in beef consumption by more than half. Up to the beginning of 2004, there had been eight BSE cases in Japan.

On May 20$^{th}$, 2003 a single BSE case was found in northern Alberta. The situation caused most importer countries to close their borders to Canadian beef immediately, movement that highly impacted the export oriented Canadian beef industry. About four months later, in September 2003, the US and Mexico, the two most important Canadian beef importer countries, reopened their borders to some Canadian beef products. Up to the end of October of 2004, the US border had not been opened to Canadian live cattle and other Canadian beef products such as bone-in beef.

The US has also registered a case of BSE. The US Secretary of Agriculture announced on December 23$^{rd}$, 2003 that a cow in Washington State had tested positive for BSE. The USDA preliminary result was confirmed by the UK world reference laboratory on December 25$^{th}$, 2003. As part of the investigation and through DNA testing, the cow was shown to have originated from a herd in Alberta, Canada. The case was believed to have occurred before the meat and bone meal ban took place in 1997 in both countries (Beef Information Centre, 2004b). Both North American cases led to the implementation of a BSE prevention and control system in Canada and the US.

#### 2.4.4.2 Escherichia coli

As with other bacteria, E. coli are naturally existing bacteria in the digestive tract of all animals. Even though most strains of E. coli do not cause any health problems to healthy humans and are even beneficial for the synthesis of vitamins; some strains can cause cramps and diarrhea in humans. There is one especially problematic strain called 0157:H7, this strain produces a toxin that can generate severe illness. E. coli 0157:H7 can be transferred to meat, unpasteurized milk and cider, as well as to many fruits and vegetables.

#### 2.4.4.3 Salmonella

As described by the World Health Organization (WHO), Salmonella are bacteria that utilize citrate as a sole carbon source. They are pathogenic for humans, causing enteric fevers, gastroenteritis, and bacteremia. Food poisoning is the most common clinical manifestation. Examples of foods involved in outbreaks of salmonellosis are eggs, poultry and other meats, raw milk and chocolate.

#### 2.4.4.4 Other Diseases

There are some other examples of food-borne illnesses such as campylobacteriosis and cholera. Campylobacteriosis could be found in raw milk, raw or undercooked poultry and drinking water. With respect to Cholera, in addition to water, rice, vegetables, millet gruel and various types of seafood have been implicated in outbreaks of cholera. As well, other food safety problems are the presence of toxins, dioxins and metals in foods.

### 2.4.5 Food Safety and Meat Demand

Burton and Young (1996) identified a short-run impact on the allocation of consumer expenditures among the meats caused by the publicity which BSE had received in the UK. They found that such impact accounted for a discernible drop in the market share of beef in the early 1990's, but even more important was a significant long-run impact of BSE, which by the end of 1993 had reduced the beef market share by 4.5%

A study for which variables explaining meat consumption includes not only an index covering press information/stories about BSE, but also Escherichia coli (E coli O157:H7) and abattoir hygiene issues, was published by Strak (1998). Using an AIDS model, they predicted beef market share during the BSE crisis on the basis that safety information negatively affected total beef sales. The authors included in their model the Meat and Livestock Commission's (MLC's) beef promotion efforts, which generated a positive return to the beef industry in a 3.97:1 ratio from the money invested in the MLC's recovery program. In general, this paper indicates that beef market share suffered significantly from BSE publicity while other meats such as pork, lamb, and poultry gained share in the UK meat market.

Lloyd et al. (2001) point to BSE and its link to nvCJD as the most significant food scare to have affected the UK and Europe in recent years. The food publicity index included in their model shows the importance of information with respect to shifts in the demand function; it plays a key role in the long-run evolution of UK beef prices. Their results suggest that UK beef prices were responsive to the public's awareness of food safety issues in the 1990's.

Negative TV coverage has also been studied to account for the BSE scare impact on the demand for beef (Verbeke and Ward, 2001). These findings show the immense impact of negative publicity based on data from Belgium. The results clearly show the dramatic impact of negative press on the beef/veal industry. The TV coverage effect is significantly negative for beef/veal and positive for pork consumption.

In the US, it has been found that beef safety information had a modest impact on beef consumption (Flake and Patterson, 1999). A possible reason for this is that people may perceive that major events such as BSE or the Foot and Mouth Disease (FMD) are external issues that have not really affected the American industry.

**2.4.6 Social Marketing**

Health Canada defines social marketing as a planned process for influencing change. This change might be in consumer behaviour and impact food choices. Examples of Canadian organizations with formal social marketing programs related to food consumption are the Canadian Cancer Society with its '5 to 10 a day... Are You Getting Enough', the Heart and Stroke Foundation with the 'Health Check' program, the Office of Nutrition Policy and Promotion at Health Canada with 'Canada's Food Guide', the

Canadian Diabetes Association with 'Healthy Eating is in Store for You', and the Dietitians of Canada with 'Eat well, Live well'.

### 2.4.6.1 Heart and Stroke Foundation of Canada (Health Check Program)

The Heart and Stroke Foundation of Canada (HSFC) is an institution dedicated to prevent or reduce disability and death from heart disease and stroke through research, health promotion and advocacy. It is composed of one national and ten provincial foundations, and is supported by more than 250,000 volunteers. In 2003, the HSFC together with the various provincial foundations raised $113 million, and expended around 27 percent ($28 million) of that amount in health promotion programs. The objective of health promotion is to help people learn how to live healthier lives. With respect to eating, the foundation states: "Healthy eating is critical to good health, and the HSFC has long been active in promoting this as part of a heart healthy lifestyle. The newest addition to the HSFC's many healthy eating initiatives, Health Check™, is a food information program that helps consumers when they shop for healthy groceries. Health Check™ helps make the healthy choice the easy choice."

Health Check is a food information program, based on Canada's Food Guide to Healthy Eating, aimed to help consumers make better decisions when at the grocery store. The program works by displaying the Health Check logo on food items authorized by the HSFC. Individual products are assessed within their category in order to receive the Health Check symbol. The different categories are grain products, vegetables and fruit, milk products, meat and alternatives, other foods, and combination foods. If a product bears the symbol it means that it has been reviewed by the Foundation and meets specific nutrient criteria. The program is intended to signal what products can be part of a healthy and balanced diet for people aged four years or older.

#### 2.4.6.2 Canadian Cancer Society (5 to 10 a day... Are You Getting Enough?)

The Canadian Cancer Society (CCS) is a community-based organization with national offices in Toronto and Ottawa, and 10 provincial and territorial divisions. Approximately, there are 220,000 volunteers and 550 full-time staff whose mission is the eradication of cancer and the enhancement of the quality of life of people living with cancer. In 2003, the CCS raised $176 million across Canada and invested around $23 million (approximately 13 percent of total revenues) in public education. With respect to healthy eating, the CCS together with the HSFC launched, in June 1999, a joint campaign to promote consumption of vegetables and fruit. The award-wining social marketing campaign is supported by the Canadian Produce Marketing Association and was based on a 1997 report showing a definite relationship between diet and cancer.

The campaign is called '5 to 10 a Day... Are You Getting Enough?' and encourages Canadians to eat at least five servings of vegetables and fruit a day as part of a healthy diet, just as described in Canada's Food Guide to Healthy Eating, and a healthy lifestyle. It gives people tips about how to increase vegetables and fruit consumption during breakfast, lunch and supper. With ongoing media coverage, aired public service announcements and a website, the aim of the '5 to 10 a day' campaign is not only to create awareness, but also to change people's eating habits, within a healthy, active lifestyle.

#### 2.4.6.3 Office of Nutrition Policy and Promotion at Health Canada (Canada's Food Guide)

The Office of Nutrition Policy and Promotion (ONPP) serves as a focal point for nutrition within Health Canada. Its objective is the promotion of the nutritional health and wellbeing of Canadians by defining, promoting and implementing health policies, which have the aim of being evidence-based nutrition policies. The ONPP, based on national and international sources of scientific information, manages and disseminates nutrition knowledge. With respect to the general public adoption of nutrition guidelines that promote health, the ONPP encourages Canadians to follow Canada's Food Guide to Healthy Eating.

The Canadian Food Guide was first published as Canada's Official Food Rules in 1942 and was revised and changed in 1944, 1949, 1961, 1977, 1982, and 1992 (Health Canada, 2002). The currently used food guide, launched in 1992, promotes dietary diversity and reduced fat consumption, as well as an active lifestyle. The aim was to encourage eating habits that would decrease the risk of developing diet-related diseases (Health Canada, 1997). The actual food guide, Canada's Food Guide to Healthy Eating, is also under revision since 2002. Although the review has confirmed the appropriateness of the guide with respect to current science, it has been found that Canadians have some problems interpreting and using the Food Guide, a situation that has encouraged Health Canada to undergo a revision of the guide (Health Canada, 2004). With respect to social marketing, Canada's Food Guide to Healthy Eating has been promoted and disseminated since it was launched in 1992; encouraging educators and communicators to deeply understand the guide in order to promote it, making the guide directly available to the public without any charge, encouraging people to use the guide as a healthy eating tool.

**2.4.6.4 Canadian Diabetes Association (Healthy Eating is in Store for You)**

The Canadian Diabetes Association (CDA), which was formed as such in 1953, is the largest non-governmental supporter of diabetes research, education and advocacy in Canada. Currently the CDA has more than 150 branches across the country. Its mission is to promote the health of Canadians through diabetes research, education, service and advocacy. With respect to nutrition education, the CDA promotes healthy eating on the premise that diabetes patients must be careful selecting what they eat and also because of the possible association of diet with the development of the illness. Currently, the CDA is engaged in a healthy eating awareness program called Healthy Eating is in Store for You (HESY).

HESY was launched in 2003 as a program intended to help consumers make healthy food choices through better use of the nutrition information on the label of packaged foods. The program received funding from Health Canada and is sponsored by the CDA and Dietitians of Canada (DC). There are some other national organizations supporting the program, including non-profit organizations, consumer associations, private councils and even a food company. These other groups form a National Advisory Committee and help in the guidance of all aspects of the program. The program has three basic objectives which are; develop or increase knowledge about reading nutritional labels, increase the use of nutritional knowledge to select healthy foodstuffs, and make consumers aware of the fact that CDA and DC are credible sources of nutrition information about packaged food labels. HESY is a program targeted to specific population groups (adult women with families, low income Canadians, individuals with lower literacy and individuals who have or are at risk of developing type 2 diabetes). As well, the program is intended to reach intermediate educators and processors and retailers of food. The program offers to consumers easy to read fact sheets, activities (such as in-store education) and an online shopping experience with the 'virtual grocery store'.

**2.4.6.5 Dietitians of Canada (Eat Well, Live Well)**

Dietitians of Canada (DC) is a nation-wide organization formed by professional dietitians. As stated by the organization, DC provides leadership and supports its members to use their expertise in food and nutrition to promote health and well-being. DC has around 5000 members and is one of the biggest organizations of its type in the world. One of the initiatives promoting healthy eating by DC is called Eat Well, Live Well.

Eat Well, Live Well is a comprehensive program that includes various healthy eating awareness tools. Among them, some web-based interactive learning tools:

- Nutrition Challenge (an interactive learning tool to assess nutrition knowledge)
- Nutrition Profile (a tool which helps to compare one's food choices to the actual recommended intakes)
- Meal Planner (a resource to help you determine the kinds and amounts of food to eat)
- Healthy Body Quiz (a Body Mass Index calculator and a physical activity quiz)
- A FAQ's section and some fact sheets.
- Virtual Kitchen (with information about a number of common food items)

- Let's Make a Meal (a tool to build a one-day menu and compare it to the servings recommended in Canada's Food Guide to Healthy Eating)
- One Day @ a Time (a tool with different healthy eating habits that one can experience during a normal day intended to help people on the run to improve nutrition)

Other than the web-based resources, the DC has been organizing a national annual campaign called March is Nutrition Month since the early 1980's. Each year the campaign has a specific theme and the latest encourages school aged children and youth to live active lives while eating healthy. The 2004 campaign theme is: Eat Well, Play Well.

**2.4.6.6 General Comments on Social Marketing. Can These Programs Increase Nutrition Awareness and Impact Food Consumption Choices?**

Food information programs, such as the HSFC Health Check program, are becoming increasingly popular ways to help consumers select a healthy diet (Smith et al., 2002). As Smith et al. (2002) define them; food information programs (FIP's) are a form of nutritional labeling whereby a manufacturer uses a logo to highlight foods with nutritional characteristics that aid in promoting health or reducing disease risk. In their literature review about FIP's, they go through programs from Australia, New Zealand, Sweden, United States and the Canadian Health Check program. Experiences from other countries, where FIP's have been in place for considerable time, indicate that consumers think about FIP's as being useful and valuable. As well, consumers reported high awareness and use of the program. At the time of the study, Health Check had been in place for around one year and low awareness of it was found due to the novelty of the program. Though, as much as 88 percent of Canadians thought the logo was useful. With respect to food purchases, Smith et al. (2002) reviewed a couple of Australian studies. The first indicates that 51 percent of women and 31 percent of men claimed to have bought food with a FIP logo. The second study indicates that 68 percent of women and 55 percent of men report that the presence of the certified logo would persuade them to change to a brand bearing the logo. In Canada, they reviewed a study that found that 48 percent and 38 percent of Canadians would be somewhat likely and very likely, respectively, to try a food with the Health Check logo.

Despite the popularity of Canada's Food Guide to Healthy Eating, there is little research about educators', health practitioners', and grocery shoppers' perceptions and use of the guide (Garcia and Piche, 2001). Given this fact, Garcia and Piche (2001) studied grocery shoppers' perceptions and use of the food guide. Their survey found that more than 79 percent of respondents reported the guide was useful or very useful, 75 percent reported awareness of the messages on the guide and about 66 percent indicated that they had made some changes in their eating habits. With respect to meat consumption, 17 percent of respondents reported trying to eat leaner meats. Therefore, there is a possibility that recommendations made in the food guide might have impacted overall meat consumption in Canada.

### 2.4.7 Effects of Advertising (Generic, Brand, Restaurant)

Different types of advertising, mainly generic and brand advertising, have been included in meat demand analyses following various approaches. Advertising has been treated as a demand shifter (i.e. Alston, Chalfant and Piggot, 1995; Brester and Schroeder, 1995; Goddard and Cozzarin, 1992; Herrmann, Thompson and Krischik-

Bautz, 2002; Kinnucan et al., 1997, Piggot et al., 1996; Verbeke and Ward, 2001), as a translating parameter (i.e. Alston, Chalfant and Piggot, 2000; Boetel and Liu, 2002; Comeau, Mittelhammer and Wahl, 1997), and as an augmenting term (i.e. Chin and Weaver, 2002).

Some of the major results obtained using the demand shifter approach when doing meat demand analysis are pointed out next. Including both generic and brand advertising and using quarterly data from 1970 to 1993, Brester and Schroeder (1995) found that, contrary to what advertising is designed for (increase demand), generic advertising for beef and pork had no significant impact on demand. They found that branded advertising effects were significant. It is worth noting that, additionally to the demand shifter method, they also used a scaling approach. Piggott et al. (1996), in their analysis of the Australian meat market, used alternative functional forms and dynamic specifications in their attempt to quantify the impact of producer promotion programs on the demand for various meats. Consistent across functional forms was beef generic advertising, having an own positive effect and a cross negative effect on chicken. Pork generic advertising had no significant effects on consumption. In their evaluation of health information and generic advertising in the US, Kinnucan et al. (1997) found that advertising elasticities were unstable, and conclude that the effects of generic advertising programs for beef, pork and fish are uncertain for the US meat market. Verbeke and Ward (2001), in their analysis about the Belgium meat market, include both generic and brand TV advertising summed up together for beef/veal and pork/mixture. Beef advertising effects are not significant for beef consumption but beef advertising significantly decreases pork/mixture and increases poultry consumption. Pork advertising is found to have a significant and positive own effect. A study analyzing the German meat market from 1995 to 1998 found that beef generic advertising had successfully increased beef consumption by 4.5 percent (Herrmann, Thompson and Krischik-Bautz, 2002).

The translating parameter approach has also been used for the analysis of meat demand. The demand for US meat in Japan and the impact of the Market Promotion Program (MPP) and the Target Export Assistance (TEA) advertising and promotion are the chief concerns of a paper by Comeau, Mittelhammer and Wahl (1997). Their analysis concludes that beef advertising has a positive and significant own effect, while pork and poultry advertising do not significantly affect demand for either commodity. Alston, Chalfant and Piggot (2000) measured welfare in the presence of generic advertising, and used a previous meat model (specified by themselves) to simulate the impact on consumer and producer surplus of changes in generic advertising expenditures. Boetel and Liu (2002), in their US meat demand system, found that generic advertising of both beef and pork are excessive. According to them, a decrease in the amount invested in generic advertising could lead to a benefit-maximized condition. Their findings indicate that there are negative spillovers between pork and beef and that pork advertising spreads positively over poultry consumption.

Few studies have been done about the effects of advertising in the demand for meat in Canada. In their preliminary look at advertising of various commodities, Goddard and Cozzarin (1992) estimated various models and found that many of the own-advertising effects exhibited counterintuitive signs in their various models. In general, they concluded that the results were sensible to functional form and to the method of including advertising. Cranfield and Goddard (1999) specified a North American beef industry model. Their results indicate that brand and generic advertising significantly increased American and Canadian beef demand. They found that historic advertising expenditures generated a net profit for Canadian producers.

Further empirical work needs to be done about the impacts of the various kinds of advertising on Canadian meat demand. As well, the inclusion of some other information variables such as health and food safety information should be included in the analysis. No study has taken into account a comprehensive set of informational variables to quantify their impacts on meat demand in Canada, and their interaction when estimated all together in a demand system. Not only does this thesis attempt to conduct empirical work addressing the inclusion of various information variables in a demand model, but also to use different data sets (time series and cross sectional) to prove the robustness of the estimates.

### 2.4.8 Demographic Changes and Product Development

Changing demographics has been receiving increased attention when it comes to the demand for food. The fact that more and more women are part of the labour force and that there is too little time to prepare foods at home is one of the main aspects of it. Convenience and quickness are keywords in the new market order. Schroeder, Marsh and Mintert (2000) found that as more women entered into the labour force, and consequently there was less time available for food preparation, beef demand declined. From 1992 to 1999, beef demand decreased by 1.3 percent annually (on average). Meanwhile, the impact on poultry demand was positive. They assume this positive impact on poultry has to do with the fact that the poultry industry has offered more convenient products to consumers, while the beef sector has failed to do so.

In Canada, the percentage of females in the labour force increased from 39.8 percent in 1980 to 46.4 percent in 2003. This change might have caused an increased demand for convenient, easy-to-prepare, ready-to-eat food choices. A higher opportunity cost of food preparation time might have also fostered consumption of food items at fast food establishments, which offer relatively low-priced meals. The creation of new products that offer what consumers are demanding represents a business opportunity for the beef industry. Poor new product development strategies during the last years, on the part of the industry, and reduced time for food preparation shifted consumer purchases to other more convenient alternatives.

## 2.5 Summary of Canadian Studies

Canadian meat demand analyses have ranged from single equations to demand systems to different functional forms to annual to quarterly data to whether or not test for structural change, but in no case has there been an analysis including information variables other than advertising. There also has been variation with respect to the number of meat commodities included, ranging from three (beef, pork and chicken) to six, where the other three commodities could be fish, turkey, lamb or veal.

The first published Canadian meat demand analysis, Trypos and Tryphonopoulus (1973), looked at beef, pork, chicken, lamb, and veal annual consumption and modeled such commodities with a linear specification. Hassan and Katz (1975) included most meat commodities in their Seemingly Unrelated Regression (SUR) analysis, using annual data on beef, pork, chicken, lamb, veal and turkey. Three analyses (Hassan and Johnson, 1979a; Hassan and Johnson, 1979b; Hassan and Johnson, 1983) included beef, pork, chicken, turkey and veal, and used quarterly data from 1965 to 1976. The first of them

(Hassan and Johnson, 1979a) uses Box-Cox transformations to prove different functional forms (linear, double log, semi-log, log-inverse and general).The second (Hassan and Johnson, 1979b) uses linear OLS to estimate meat demand in Canada. And thirdly, Hassan and Johnson (1983) used various parameter estimation procedures (OLS, GLS and SUR) with seasonal dummy variables.

Young (1987) specified and estimated four individual demand equations with common explanatory variables for beef, pork, chicken and turkey. This study makes systematic specifications of the equations, using four different transformations on the data to generate the following functional forms; double-log, linear, linear-log and Box-Cox. Tests for structural change indicate that pork, chicken and turkey demand changed after the mid 1970's but beef demand had not been affected by changed tastes.

Structural change is the main preoccupation of a study by Atkins, Kerr and McGivern (1989). They model high quality beef, pork and chicken consumption and apply Chow tests breaking the data up into 1968-1974 and 1977-1986. Their findings indicate a significant structural break in beef demand.

Nineteen-ninety-one was a prolific year with respect to Canadian meat demand analyses. Alston and Chalfant (1991) analyzed beef, pork, poultry and fish demand comparing various functional forms (linear, double log, two versions of the LA/AIDS (static and first differentiated), and Rotterdam), and show that the use of an incorrect functional form can lead to a finding of structural change. Based on their results from the Rotterdam model, they did not find changed tastes. They also applied some nonparametric tests. Chalfant, Grey and White (1991) found significant trends in

Canadian meat consumption being positive for chicken and fish while negative for beef and pork. The model used for this analysis was a LA/AIDS.

They were also interested in estimating the consistency of some demand properties (monotonicity, concavity and substitutability); their results suggest that Canadian data are consistent with both monotonicity and concavity, but contradicts substitutability. An analysis using quarterly data for beef, pork, chicken and turkey and applying a dynamic specification of the AIDS model (Chen and Veeman, 1991) found structural change. The authors state that changes in tastes could be due to health consciousness, changes in the nature of poultry products and/or the growth in fast food establishments. Seasonal variables are not used in this study.

Also from the same year, Reynolds and Goddard (1991) dealt with structural change and analyzed beef, pork and chicken consumption. Utilizing a first differentiated LA/AIDS model with seasonal dummy variables, they found significant structural change starting the first quarter of 1975, which might be due to health concerns. The elasticities are significantly different before and after structural change occur. The first attempt to include advertising in a Canadian meat demand model was made by Goddard and Cozzarin (1992). In their preliminary look at advertising (modeled as an independent demand shifter) for various commodities, they used two models, the translog and the AIDS to analyze annual data on the Canadian market. Among the goods that they took into account for this analysis the meat products were beef, pork and chicken. Elasticities were a bit different between models.

Moschini and Vissa (1993) used a mixed Rotterdam specification with seasonal dummies to model beef, pork and chicken consumption. Mixed demands were specified to account for supply management existent in the Canadian chicken industry.

Finally, there were two studies in 1996. Eales (1996) used both the static and dynamic AIDS and IAIDS (inverse differential AIDS) to show the importance of dynamics and endogeneity in the demand for meat in Canada. In his analysis he utilized quarterly data on beef, pork and chicken. Xu and Veeman (1996) test for the specification of functional form and structural change, since both are important when it comes to the estimation of the parameters. Joint non-nested testing of both is applied for the linear AIDS and Rotterdam models with and without structural change, incorporated using a gradual transition specification. The test of models with structural change shows that, for Canadian meat consumption, the gradual transition almost ideal model is preferred over the gradual-transition Rotterdam model. This latter analysis is based on quarterly data for the Canadian meat market.

**2.6 Summary of Literature Review**

The present chapter offers a comprehensive review of the issues surrounding meat demand analysis. Departing from consumer theory, it offers an overview of the consumer problems of utility maximization and expenditure minimization, and then goes on to indicate the importance of weak separability for the specification of demand systems. It points out the differences between time series and cross-sectional analyses and their advantages/disadvantages, signaling that both are useful for the case of this study. It also concludes that flexible functional forms are the option to be considered for the two kinds of data used in this thesis, and that demand systems are preferred over single equation models. It explores the different approaches used in the literature to include information variables in demand analyses. With respect to the effect of the various information variables on meat demand, this literature review considers a number of different possible information variables to be included in the empirical estimation of this thesis; health concerns, food safety issues, social marketing programs and advertising expenditures.

Specifically with respect to information indices about health concerns and food safety issues, it was pointed out that, for the purposes of this thesis, it is considered more appropriate to create these indices taking into account the information found in newspaper articles. However, it has been discussed how information indices have been used in other studies about food demand in general and about meat demand more specifically.

In order to address how meat demand analyses are conventionally carried out, in this chapter an appraisal of the previous literature on the determination of demand for beef/meat in other high income countries (Canada, the US and the EU) is undertaken. The basis to accomplish the objectives of this thesis has been established.

In the next chapter the methods used for the empirical estimation of this thesis are looked at, and the functional forms used for time series and cross-sectional modeling are specified. How exactly the various information variables are included in the models is also specified in chapter 3.

# Chapter 3

# Methods

## 3.1 Introduction

In the second chapter of this thesis, the theoretical basis of the present analysis was set. Although the advantages of flexible functional forms and demand systems were mentioned, it was not specified what functional forms where going to be used, and how the information variables were going to be incorporated in the analysis. The present chapter addresses such issues and the characteristics of the models employed in the empirical estimation of this thesis are described.

## 3.2 Description of Functional Forms

The choice of functional form is a critical one in carrying out demand analysis. It is extremely important because the choice of functional form can make a difference in the estimation results of the empirical analysis. We have established that the better way to represent a broad range of income, prices and information responses is by employing a flexible functional form. Nevertheless, there exist a number of different functional forms which are flexible. The most common of them are the Translog model (Christensen, Jorgenson, and Lau, 1975), the Almost Ideal Demand System (AIDS) model (Deaton and Muellbauer, 1980b), Generalized AIDS model (Bollino and Violi, 1990), An Implicitly Directly Additive Demand System (Rimmer and Powell, 1996), Quadratic AIDS (Banks, Blundell and Lewbel, 1997) and Lewbel (Lewbel, 1989a). Among all the possibilities of flexible forms, it is difficult to choose one over the other because all offer similar properties and require similar estimation techniques. In order to approximate the true functional form for the demand for meat in Canada, it has been thought that the

Generalized Box-Cox (GBC) model is a good option for the time series data and the AIDS model is a good match for the cross-sectional data. The GBC functional form provides a general and flexible functional form that contains the Translog, the Generalized Leontief and the Generalized Square Root Quadratic functions as special cases. Thus, The GBC function is employed for the time series empirical analysis of this thesis because it is considered a more general form of the flexibles (Amuah, 1985). The AIDS model is used for the cross sectional estimation because, although it is a flexible functional form, it is no as elaborated as other flexible models. Thus, it provides the advantages of flexible forms without complicating estimation, which is by itself an issue when estimating household demand for foods. Table 3-1 presents a summary of the general characteristics of both functional forms.

Table 3-1 Summary of characteristics of the functional forms used in this thesis

| | **Generalized Box-Cox Model** | **AIDS Model** |
|---|---|---|
| Derived from | Generalized Box-Cox indirect utility function<br>$\psi(X)=\sum_i \alpha_i (X_i^{\lambda}-1)/\lambda+\frac{1}{2}\left[\sum_i\sum_j \beta_{ij}(X_i^{\lambda}-1)/\lambda(X_j^{\lambda}-1)/\lambda\right]$ | Expenditure function<br>$\ln c(u,p)=a(p)+ub(p)$ |
| Share equations | $w_{it}=\dfrac{\alpha_i X_i^{\lambda}+\sum_j \beta_{ij}X_i^{\lambda}(X_j^{\lambda}-1)/\lambda}{\sum_i\left[\alpha_i X_i^{\lambda}+\sum_j \beta_{ij}X_i^{\lambda}(X_j^{\lambda}-1)/\lambda\right]}$ | $w_i=a_i+\sum_j \gamma_{ij}\ln p_j+\beta_i \ln(X/P)$ |
| Simmetry | $\beta_{ij}=\beta_{ji}$ | $\gamma_{ij}=\gamma_{ji}$ |
| Normalization of the parameters | $\sum_i \alpha_i=-1$ | |
| Homotheticity | | $\beta_i=0$ |

| | | |
|---|---|---|
| Homogeneity | $\beta_{ij}=\beta_{ji},\ \sum_j \beta_{ij}=0,\ \sum_k \alpha=-1$ | $\sum_{j=1}^{n}\gamma_{ij}=0$ |
| Adding up | | $\sum_{i=1}^{n}\alpha_i=1, \sum_{i=1}^{n}\beta_i=0$<br>$\sum_{i=1}^{n}\gamma_{ij}=0,$<br>$\sum_{i=1}^{0} f_{ij}=0, \sum_{i=1}^{n} g_{ij}=0$ |

The next section more completely describes each of the two functional forms and specifies the way in which the information variables are included in the models.

### 3.2.1 Generalized Box-Cox

Consistent with consumer theory, the time series empirical analysis of this thesis is conducted as a two stage budgeting problem. Weak separability implies that a group of goods (meat products in the case of this thesis) can be separated from the rest of the consumption commodities, so that preferences within groups can be described independently of the quantities in other groups (Deaton and Muellbauer, 1980a).

The first stage of the demand system can be specified as a log-log relationship and can be represented by the following general form:

$$T.E._t = \sum_i P_{it} Q_{it} = f(P_t, Y_t, D_t, FSI_t, HI_t, T_t, AD_t, FG_t, T.E._{t-1})$$

Where:

$T.E._t$ is total expenditure on beef, pork and chicken at time $t$;

$P_{it}$ is the price of the $i^{th}$ meat at time $t$;

$Q_{it}$ stands for the quantity consumed of the $i^{th}$ meat at time $t$;

$P_t$ represents the weighted average price for the three meats at time $t$;

$Y_t$ is real per capita disposable income at time $t$;

$D_t$ is a matrix of seasonal (quarterly) dummy variables;

$FSI_t$ is the value of the meat food safety index at time $t$;

$HI_t$ is the value of the meat health index at time $t$;

$T_t$, is time;

$AD_t$ represents total meat advertising expenditures at time $t$;

$FG_t$ represents the percentage of meat servings with respect to total servings recommended in the various Canadian food guides; and

$T.E._{t-1}$ is the lagged dependent variable.

And the specific form:

$$\ln T.E._t = a + b\ln P_t + c\ln Y_t + d\sum_{k=1}^{3} D_{kt} + eT_t + f\ln TE_{t-1}$$

$$+ g\ln AD_t + h\ln CFG_t + l\ln FS_t + m\ln HI_t + \varepsilon_t$$

where $a,b,c,d,e,f,g,h,l$ and $m$ are parameters to be estimated, and $\varepsilon_t$ is a random disturbance term. $D_{kt}$ is a dummy variable for the $k^{th}$ quarter at time $t$. For the dummy variables the $4^{th}$ quarter of each year is excluded. This ensures no linear dependence between the intercept and the set of seasonal dummies.

It is worth noting at this point that the weighted average price for the three meats used in the empirical estimation of the first stage is based on the Composite Commodity Theorem, which asserts that if a group of prices move in parallel, then the corresponding group of commodities can be treated as a single good (Deaton and Muellbauer, 1980a).

Some empirical analyses have been done utilizing Box-Cox transformations in studying meat demand with the objective of proving for different functional forms or to have flexible functional forms but only as one stage systems, examples of those are Hassan and Johnson (1979a), Pope, Green and Eales (1980), Moschini and Meilke (1984) and Young (1987). In this study, the second stage of the model will be composed of a system of equations explaining the demand for each meat type as a function of prices of all meats, total expenditure on meats, the food safety and health indices and the various kinds of advertising (generic, brand and restaurant). The functional form for the second stage of the demand system is a Generalized Box-Cox (GBC) indirect utility function, which utilizes normalized prices $\left(P_i/_{T.E.}\right)$ and will be estimated with some restrictions such as symmetry imposed. Then, from the GBC indirect utility function and through Roy's identity a group of share equations representing the value of each meat type as a proportion of total expenditure on meats will be derived. The GBC indirect utility function, suggested by Appelbaum (1979) and utilized by Goddard (1984) and Amuah (1985) to study the international beef market and the butter and margarine market in Canada respectively, is given by:

$$\psi(\delta)=\sum_i \alpha_i X_i(\lambda)+\frac{1}{2}\left[\sum_i\sum_j \beta_{ij} X_i(\lambda) X_j(\lambda)\right]$$

Where:

| | |
|---|---|
| $\psi$ | is utility; |
| $X_i$ | are normalized prices $\left(P_i/_{T.E.}\right)$; |
| $\beta_{ij}=\beta_{ji}$ | symmetry condition; and |
| $\psi(\delta)$ and $X_i(\lambda)$ | are Box-Cox transformations defined as: |

$$\psi(\delta) = (\psi^{2\delta} - 1)/2\delta$$
$$X_i(\lambda) = (X_i^{\lambda} - 1)/\lambda$$

By imposing some restrictions on the values that $\delta$ and $\lambda$ can take, we could generate different functional forms, examples of those are the translog function (if $\delta = \lambda = 0$), the generalized Leontief function (if $\delta = \lambda = \frac{1}{2}$), and the generalized square root quadratic function (if $\delta = \lambda = 1$). In this thesis the GBC functional form optimizing the parameter $\lambda$ and assuming a non-mixed indirect utility function will be estimated.

Then, the general non-homothetic indirect utility function is:

$$\psi(X) = \sum_i \alpha_i (X_i^{\lambda} - 1)/\lambda + \frac{1}{2}\left[\sum_i \sum_j \beta_{ij}(X_i^{\lambda} - 1)/\lambda (X_j^{\lambda} - 1)/\lambda\right]$$

Using this indirect utility function and applying Roy's identity we get the following general share equation:

$$w_{it} = \frac{\alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda}(X_j^{\lambda} - 1)/\lambda}{\sum_i \left[\alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda}(X_j^{\lambda} - 1)/\lambda\right]}$$

The restrictions imposed on the model are symmetry ($\beta_{ij} = \beta_{ji}$), and the normalization of the parameters $\sum_i \alpha_i = -1$, since the expenditure share equations are homogeneous of degree zero in prices and total expenditure. For the purposes of the estimation, only $n-1$ share equations are estimated since the sum of market shares must be unity.

Media messages can be thought of as playing a similar role to advertising in their impact on demand, except that, whereas advertising is undertaken explicitly to increase sales, messages de not usually have this objective (Burton and Young, 1996). When the assumption of perfect information and constant tastes pointed out by Chang and Kinnucan (1991) is relaxed, consumer demand models can be extended to incorporate dynamic consumer behaviour, allowing some parameters that characterize preferences to vary with exogenous variables (Verbeke and Ward, 2001). After specifying an indirect utility function including advertising expenditures (generic, brand and restaurant) and the media indices (food safety and health) as demand shifters, we can derive the share equations through Roy's identity. Thus, the expenditure share equations are derived as follows:

$$
w_{it} = \frac{\begin{gathered} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{gathered}}{\sum_i \left[ \begin{gathered} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda} (HI_j - 1)/\lambda \end{gathered} \right]}
$$

For empirical purposes, it is assumed that these are stochastic equations with a normally distributed random disturbance term with mean of zero and a non-singular variance-covariance matrix.

### 3.2.2 Almost Ideal Demand System

For the cross-sectional estimation of the demand for meats in Canada, it was decided to use the Almost Ideal Demand System. The first stage of the demand system is a double log relationship specified as:

$$TE = f(P, Y, FS, H, ADV)$$

where: $TE$ is total expenditure on beef high value, beef low value, pork high value, pork low value, poultry and other meats; $P$ represents the expenditure share weighted average price for the various meats; $Y$ is income; $FS$ is the food safety index; $H$ represents the health index, and $ADV$ represents advertising expenditures.

The Almost Ideal Demand System (AIDS) has been one of the most widely used models for empirical estimation. Since its introduction by Deaton and Muellbauer (1980b), it has been recognized that the AIDS offers some important advantages over other models. As pointed out by its creators it has the next desirable characteristics:

- It gives an arbitrary first-order approximation to any demand system.
- It satisfies the axioms of choice exactly.
- It aggregates perfectly over consumers.
- It has a functional form which is consistent with known household-budget data.
- It is simple to estimate.
- It can be used to test restrictions of homogeneity and symmetry.

Therefore, it was decided that the AIDS model was a good choice for the cross sectional estimation of the present thesis.

The AIDS model is based on the representation of preferences via the cost or expenditure function. Which indicates the minimum cost of reaching a determined level of utility at given prices. The function is then $c(u,p)$. Based on Deaton and Muellbauer (1980b) and following Goddard and Cozzarin (1992) we have that:

$$\ln c(u,p) = a(p) + ub(p)$$

Where:

$$a(p) = a_0 + \sum_i a_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j$$

representing the cost of subsistence, and

$$b(p) = \beta_0 \pi p_i^{\beta_i}$$

portraying the cost of bliss.

Therefore the cost function can be represented as:

$$\ln c(u,p) = a_0 + \sum_i a_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j + u\beta_0 \pi p_i^{\beta_i}$$

If one wanted to incorporate information and demographic variables as demand shifters in the cost function, they should be incorporated in the $a(p)$ function. Changing such function following Goddard and Cozzarin (1992) and adding advertising, and food safety and health information, as well as demographics we obtain the cost function:

$$\ln c(u,p) = a_0 + \sum_i a_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j + \sum_i e_i \ln A_i + \frac{1}{2}\sum_i \sum_j d_{ij} \ln A_i \ln A_j$$

$$+ \sum_i l_i \ln FS_i + \frac{1}{2}\sum_i \sum_j m_{ij} \ln FS_i FS_j + \sum_i n_i \ln H_i + \frac{1}{2}\sum_i \sum_j o_{ij} \ln H_i H_j$$

$$+ \sum_i v \ln DEM_i + \frac{1}{2}\sum_i \sum_j w_{ij} \ln DEM_i DEM_j + \sum_i \sum_j x_{ij} \ln p_i \ln DEM_j$$

$$+ \sum_i \sum_j r_{ij} \ln p_i \ln A_j + \sum_i \sum_j s_{ij} \ln p_i \ln FS_j + \sum_i \sum_j t_{ij} \ln p_i \ln H_j + u\beta_0 \pi p_i^{\beta_i}$$

The demand functions are derived from the above equation invoking Shephard's lemma $\left[\frac{\partial c(u,p)}{\partial p_i} = q_i\right]$. In order to get the share of each commodity we multiply both sides by $\frac{p_i}{c(u,p)}$, and obtain:

$$\frac{\partial \ln c(u,p)}{\partial \ln p_i} = \frac{p_i q_i}{c(u,p)} = w_i$$

Differentiating the cost function with advertising, food safety and health information, as well as demographics as shifters, and putting it in terms of prices and expenditures, we get the next share equation:

$$w_i = a_i + \sum_j \gamma_{ij} \ln p_j + \sum_j s_{ij} \ln FS_j + \sum_j t_{ij} \ln H_j + \sum_j x_{ij} \ln DEM_j + \beta_i \ln(X/P)$$

Where:

$$w_i = \frac{p_i x_i}{\sum_i p_i x_i}$$

$p_j$ is the price of individual goods;

$FS_j$ represents the food safety indices;

$H_j$ stands for the health indices;

$DEM_j$ represents demographic characteristics;

$X$ represents total expenditures;

$P$ is a price index that can be approximated by the Stone's Index $\ln P = \sum_i w_i \ln p_i$

For estimation purposes, some restrictions are applied to the model in order to satisfy the usual demand properties. Such restrictions ensure adding up, homogeneity, and symmetry. In order for the budget shares to sum to one: $\sum_i a_i = 1$, $\sum_i \gamma_{ij} = 0$, and

$\sum_i \beta_i = 0$ (in the present context, adding up is also ensured if $\sum_i r_{ij} = 0$, $\sum_i s_{ij} = 0$, and $\sum_i t_{ij} = 0$). Homogeneity is satisfied if $\sum_i \gamma_{ij} = 0$, and symmetry is met if $\gamma_{ij} = \gamma_{ji}$. Since the system of equations must sum to one, only $n-1$ equations are estimated.

**3.3 Use of Media Indices**

In Chapter II, it was stated that the indices used in this thesis are based on newspaper reports about food safety and health. The creation of the food safety and health indices over time is undertaken for each meat type through careful searches of newspapers which are used as a proxy for all media coverage.

The Food Safety Indices (FSI's) are incorporated in the model as counts of articles. Media messages about a 'food scare' are likely to be negative or to impact negatively consumption of the meat being mentioned in the article. So, as long as one makes sure that the article's content is related with a food safety concern and a specific food, the number of articles found can be included directly into the model structure. The FSI's are counts of the number of articles related to BSE and E. coli for beef, E. coli and Salmonella for pork, and E. coli and Salmonella for chicken.

On the other hand, articles about meat consumption and health can be negative or positive. They are negative if they discourage meat consumption for being related to a specific disease, or positive if the article encourages consumption of an individual meat stating that it can be part of a healthy diet. Therefore, it is necessary to distinguish between discouraging and encouraging newspaper reports, leading to the construction of a net index. Thus, for the purposes of this thesis, the Health Indices (HI's) are incorporated in the model as net counts. The HI's are net counts (positive – negative) of the number of articles linking consumption of each meat type (beef, pork, and chicken) with cancer, heart disease, and stroke.

### 3.3.1 Time Series Indices

These media indices were obtained using the publications library of Dow Jones Interactive and take into account the number of articles published in Canada by quarter from 1976 to 2001.

### 3.3.2 Cross Sectional Media Indices

Media indices are used to measure the impact of food safety and health concerns on household demand for meat. The food safety and health indices are built using the publications library of Dow Jones Interactive and the Canadian Newsstand database of ProQuest. The indices take into account the number of newspaper articles published per quarter and per region in the periods 1995-1996 and 2000-2001.

## 3.4 Hypothesis Testing

The various media sources are expected to have specific impacts on meat consumption choices. Ideally, the three kinds of advertising considered in the empirical analysis of this thesis (generic, brand and restaurant) would increase own consumption and possibly reduce consumption of the other meats. The FSI's are expected to reduce own consumption and probably encourage consumption of the other meats. Meanwhile, the HI's are expected to impact own consumption positively, since they are net counts of newspaper articles. It might be expected to find a negative relationship of the HI's with respect to consumption of the other meats.

### 3.5 Derivation of Elasticities

A detailed derivation of the elasticities for both models the GBC and the AIDS is provided in Appendix A.

### 3.6 Two-Stage Modeling

This thesis takes the approach of modeling Canadian meat demand as a two-stage demand system. The simultaneous estimation of both stages of the system makes possible the substitution of endogenous variables from one stage into the other stage. The estimation is carried out using a dynamic approach and this provides improved estimates of the elasticities of demand. Two-stage demand systems imply interconnection between the stages, where we have total expenditure allocated over a group of goods at the first stage and individual commodities' share equations at the second.

It is particularly important to use this methodology when one is concerned with both the size and the allocation of expenditures on meats in Canada. From a two-stage estimation, it is possible to compute elasticities that combine both estimation stages, which is useful because they take into consideration that a change in an exogenous variable will affect the shares of each meat type as well as the overall budget spent on meats (Lariviere, Larue and Chalfant, 2000). These across-two stage elasticities are computed as follows:

Based on Goddard et al. (2004) and considering that $q_i = w_i M / p_i$:

Then, the general form for the across-two stage own- and cross-price elasticities is:

$$\frac{\partial q_i}{\partial p_j} = \frac{\partial w_i}{\partial p_j}\frac{M}{p_i} + \frac{\partial w_i}{\partial M}\frac{\partial M}{\partial p_j}\frac{w_i}{p_i} + \frac{\partial M}{\partial p_j}\frac{w_i}{p_i} - \frac{\partial p_i}{\partial p_j}\frac{Ew_i}{p_i^2} \quad \Rightarrow$$

$$\in_{ij}^{QP} = \frac{\partial q_i p_j}{\partial p_j q_i} = \frac{\partial w_i p_j}{\partial p_j w_i} + \left(\frac{\partial w_i M}{\partial M w_i} + 1\right)\frac{\partial X p_j}{\partial p_j M} - \phi$$

$\phi$=1 for i=j and $\phi$=0 for i≠j, $\frac{\partial p_i}{\partial p_j}$=0 for i≠j

The general form for the across-two stage own- and cross-advertising (or food safety or health) elasticities is:

$$\frac{\partial q_i}{\partial \theta_j} = \frac{\partial w_i}{\partial \theta_j}\frac{M}{p_i} + \frac{\partial w_i}{\partial X}\frac{\partial M}{\partial \theta_j}\frac{w_i}{p_i} + \frac{\partial M}{\partial \theta_j}\frac{w_i}{p_i} \quad \Rightarrow$$

$$\in_{ij}^{Q\theta} = \frac{\partial q_i \theta_j}{\partial \theta_j q_i} = \frac{\partial w_i \theta_j}{\partial \theta_j w_i} + \left\{\left(\frac{\partial w_i M}{\partial M w_i} + 1\right) \cdot \frac{\partial E \theta_j}{\partial \theta_j M}\right\}$$

where $\in_{ij}^{Q\theta}$ ($\theta$ = advertising (generic, brand or restaurant), food safety index or health index) is the advertising (generic, brand or restaurant)/food safety/health elasticity of demand for the first stage.

### 3.7 Rank of a Demand System

Lately, the specification of the rank of the demand system(s) used in any empirical analysis has received increasing attention. Rank, as defined by Lewbel (1991), is the maximum dimension of the function space spanned by the Engel curves of the demand system. This definition is extended, as he points out, from previous definitions by Gorman (1981) and himself (Lewbel, 1989b), to include all demand systems. The rank of demand systems is important because it has an impact on the degree of separability, the aggregate structure (across individuals and across goods) and the functional form structure (Lewbel, 1991).

As stated by Lewbel (2003) a demand system has rank one if and only if it is homothetic (all income elasticities are equal to 1), rank two or less is required by aggregated demands to resemble those of a representative consumer, rank three or less is a requirement for utility-derived demands that are exactly aggregable, and rank four or less is required by utility-derived deflated income demands. It is of particular importance for empirical analysis to know if demands have rank greater than three, because if they do then they cannot be exactly aggregated (Lewbel, 2003).

It has been pointed out that the AIDS model, one of the models used for the empirical estimation of this thesis, is a rank two model (Lewbel, 1991) which is an indication of exact aggregation. While no previous study indicates the exact rank of the GBC model, we know that it is a utility-derived model that displays exact aggregation, which makes it a rank three or less demand system. At the same time Lewbel (1991) indicates that rank two demands include the PIGL, PIGLOG and fractional demand systems. Muellbauer (1975) indicates that a demand system is PIGL iff "price independent generalized linearity" holds. PIGLOG refers to the logarithmic subclass of the PIGL class also defined by Muellbauer (1975). The GBC demand system belongs to the PIGLOG class and, therefore, is a rank two demand system.

### 3.8 Zeros in Cross Sectional Analyses

A widely recognized problem when carrying out empirical estimation using micro-data sources is that of zero expenditure. Food expenditure survey data usually report no expenditures on some specific items for a number of surveyed households. Surveys usually take place during a short period of time (e.g. the Food Expenditure Survey in Canada reports diary records from a two-week period). Besides, the specificity of the food being studied also causes households reporting no expenditure on such item. For example, there would be more reporting households for meat than for pork, and more for pork than for pork belly cuts. Therefore, as the time length of the survey decreases and the food category becomes more specific, the possibility of encountering more households reporting zero expenditure increases.

Chen (2000) describes the three principal reasons for having zero expenditures. They are named abstention, infrequency and cornered solution, and are related to non-consumers, infrequent buyers and potential buyers, respectively. The first arises when people simply would not buy and eat a specific food item for lifestyle, religious, health concerns or other reasons (e.g. vegans would not eat beef, Muslims would not eat pork, people with a heart condition would avoid as much as possible high-fat meat cuts). The second, infrequency, shows up when the length of time of the survey is too short for some households to report buying a specific food. Variety is an issue of increasing importance in the diet and modern home appliances increase the possibilities of home storage. Both abstention and infrequency are important issues for those who rarely or irregularly purchase a commodity. Lastly, we find people who would buy a food item only if their income increased or the price of such item decreased. These potential buyers provide the third reason for reporting zeros.

The existence of zeros in microdata represents an empirical problem that has been dealt with in different ways. One of the most common approaches used in cross sectional estimation of demand is that provided by Heckman (1979). Heckman's two-step procedure involves separate estimation of the participation and expenditure decisions. The first step involves a probit regression to determine the probability of participation (Byrne, Capps and Saha, 1996). The inverse Mills ratio is calculated from first step probit choices and then incorporated into the second step regression model (Chen, 2000). Some other approaches are Cragg (1971), Amemiya (1974) and Heien and Wessells (1990).

Most of these are two-step procedures that theoretically address the potential bias and inconsistency concerns that result from censored responses when using ordinary least squares (OLS) (Byrne, Capps and Saha, 1996). However, more recent studies have questioned the efficiency and consistency of these two-step approaches:

- "The Heien and Wessells estimator has been a favorite choice for empirical analysts for nearly a decade. We point out that the Heien and Wessells estimator is inconsistent..." (Shonkwiler and Yen, 1999).
- "Although such two-step methods are consistent, they are not invariant to the choice of which good is dropped, and they are inefficient and require specific distributional assumptions" (Golan, Perloff and Shen, 2001).
- "These multi-step procedures generally produce inefficient parameter estimates relative to the full-information maximum-likelihood (FIML) estimator, but can be useful for large demand systems with many zeros" (Yen and Huang, 2002).

Shonkwiler and Yen (1999) propose an alternative approach to the Heien and Wessells estimator and use a two-step procedure, too. Recognizing that the direct estimation using maximum-likelihood is best and becoming increasingly feasible for single equations but is still fairly complicated for systems of equations, they introduce their approach. Another recent approach was proposed by Perali and Chavas (2000), it consists, at the first stage, of the estimation of separate unrestricted equations, then, in the second step, estimation of error correlation, and finally it recovers the restricted demand parameters using minimum distance estimation. Then again, Yen and Huang (2002) point out the relative inefficiency of these procedures when compared to the FIML estimator.

Maximum-likelihood (ML) estimation and its variants (e.g. FIML, Simulated Maximum-likehood, Quasi Maximum-likelihood) are the best way to deal with the empirical problem of zero expenditures. However, it is recognized that direct maximum-likelihood estimation of systems of equations remains difficult when censoring occurs in multiple equations because of the need to evaluate multiple integrals in the likelihood function (Shonkwiler and Yen, 1999).

The problem of zero expenditure is one that requires a deep understanding of the different methodologies that can be employed to efficiently and consistently estimate a demand system using microdata. Although the problem requires further research and empirical work when using the Canadian Food Expenditure Survey, it is considered that the estimation of a straight demand system using microdata sources could provide a good understanding of the factors affecting the demand for meat in Canada. A number of previous studies have estimated the demand for various foods just straightly estimating single equations or demand systems using microdata (Capps and Havlicek, 1984; Capps, Tedford and Havlicek, 1985; Heien and Pompelli, 1988; Abdulai et al., 1999; Park and Davis, 2001; Abdulai, 2002; Chung and Kaiser, 2002; Abdulai and Aubert, 2004).

### 3.9 Summary

This chapter presents the description of the methods used for the empirical analysis of this thesis. It provides a revision of the most common flexible functional forms and goes on to describe the forms used in this study; the Generalized Box-Cox (time series) and the AIDS (cross-sectional). The GBC, comprising the Translog, the Generalized Leontief and the Generalized Square Root Quadratic functions, is a general form of the flexibles and provides all the advantages of estimating cross effects. The

AIDS has the advantages of the flexible functional forms but it also offers a less complicated estimation for cross sectional data. As well, this chapter presents the expected impacts of the different information variables on Canadian meat demand used in the empirical estimation, and provides an insight into the problem of zero expenditure when using microdata. The use of two-stage demand systems provides improved estimates of the elasticities of demand by taking into account the interactions across total expenditure and the expenditures shares. This is particularly important for the estimation of the size and the allocation of expenditures on meats.

# Chapter 4

# Time Series Results

## 4.1 Introduction

In this chapter the results from the first estimation carried out in this study; the impact of prices, income, generic advertising, brand advertising, fast food restaurant advertising, food safety indices and health indices on Canadian meat consumption using a time series database (1978-2001) are presented. In the following chapter the results obtained from the estimation of a demand system using microdata are provided. In chapter six, results are summarized in terms of the robustness of the estimation results.

## 4.2 Time Series Data

The time series data used to estimate the first demand system in this thesis include consumption of beef, pork and chicken. Quarterly meat disappearance in Canada[2] from 1978 to 2001 is used. Meat disappearance was calculated with data published by Agriculture Canada and Statistics Canada, as well as with non-public data sources. It is important to note that disappearance takes into consideration all the meat available in the Canadian market on a carcass basis. Some of that meat could become waste at the processor, retailer or consumer levels (e.g. bones or excess fat). Furthermore, even if it is put on the consumer plate there may be some plate waste and some could be used as pet food. Canadian disappearance data is presented in Appendix B. Population, CPI for all goods, disposable income, and CPI's for fresh or frozen beef, pork, and chicken were obtained from CANSIM, which is a large time series database providing access to current

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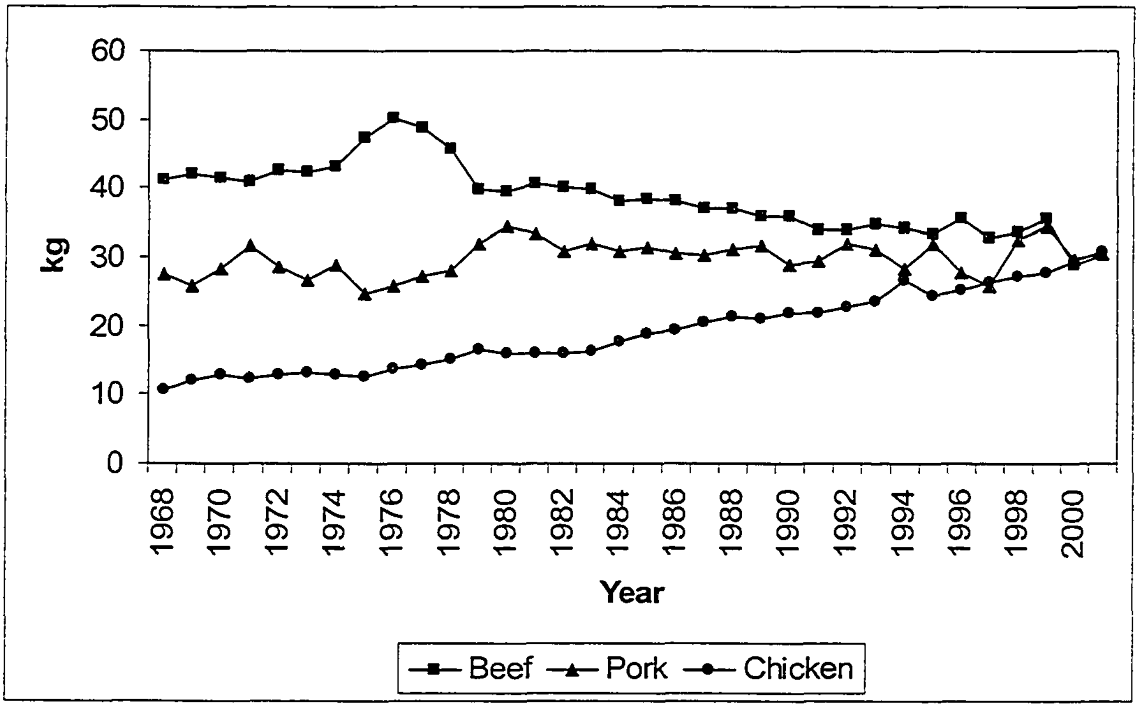
[2] Disappearance is equal to total inspected supply, plus total uninspected supply, plus stocks at the beginning of the period, minus stocks at the end of the period, minus exports, plus imports.

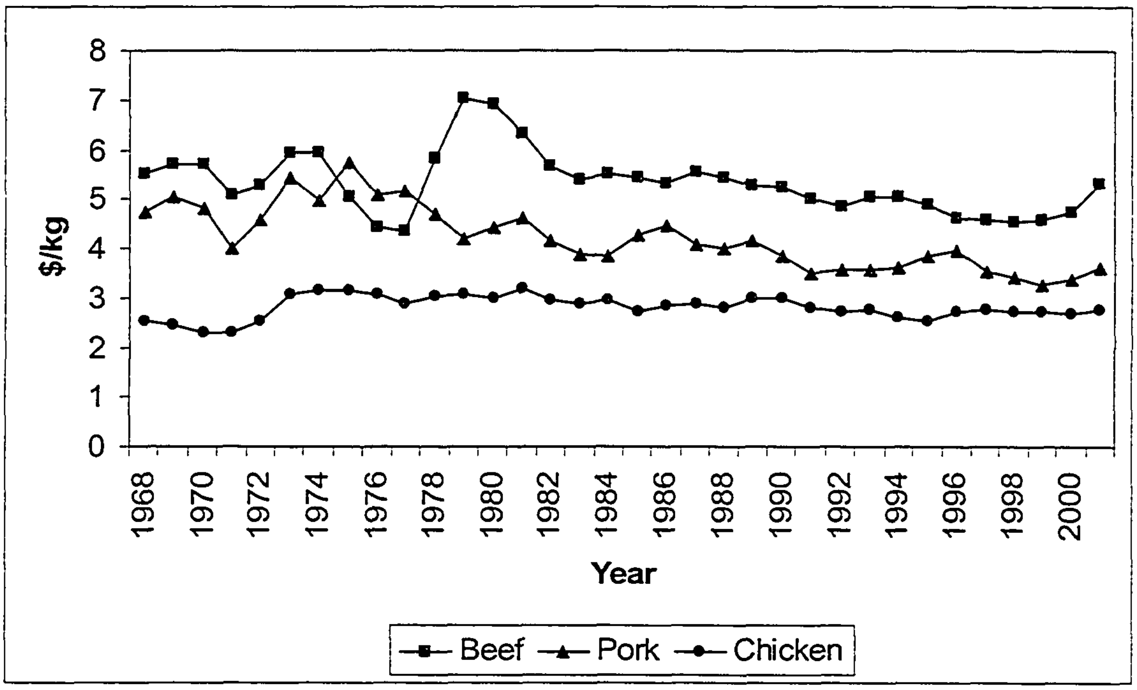
and historical series collected on a wide variety of subjects by Statistics Canada and other government agencies, such as, the Bank of Canada. Figures 4-1 and 4-2 show quarterly per capita meat disappearance in Canada and prices of the three commodities considered in the time series estimation of this thesis, respectively.

Figure 4-1 Per capita consumption of beef, pork and chicken in Canada (1968-2001)




Source: Elaborated with information from Agriculture and Agri-Food Canada and Statistics Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources.

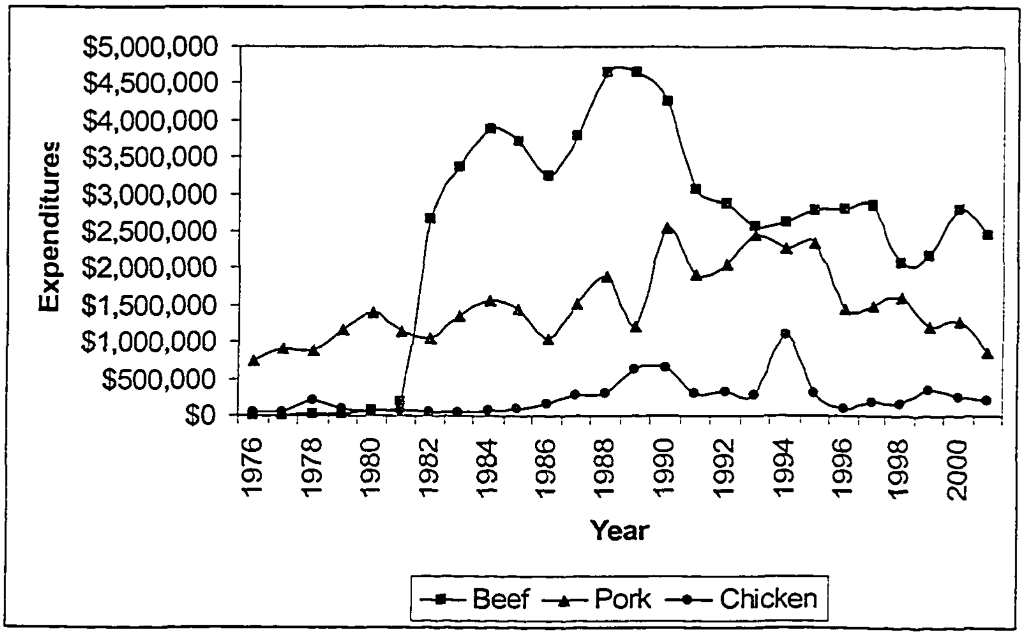
Figure 4-2 Real prices for beef, pork and chicken in Canada (1981 dollars)




Source Elaborated with information from Statistics Canada (CANSIM).

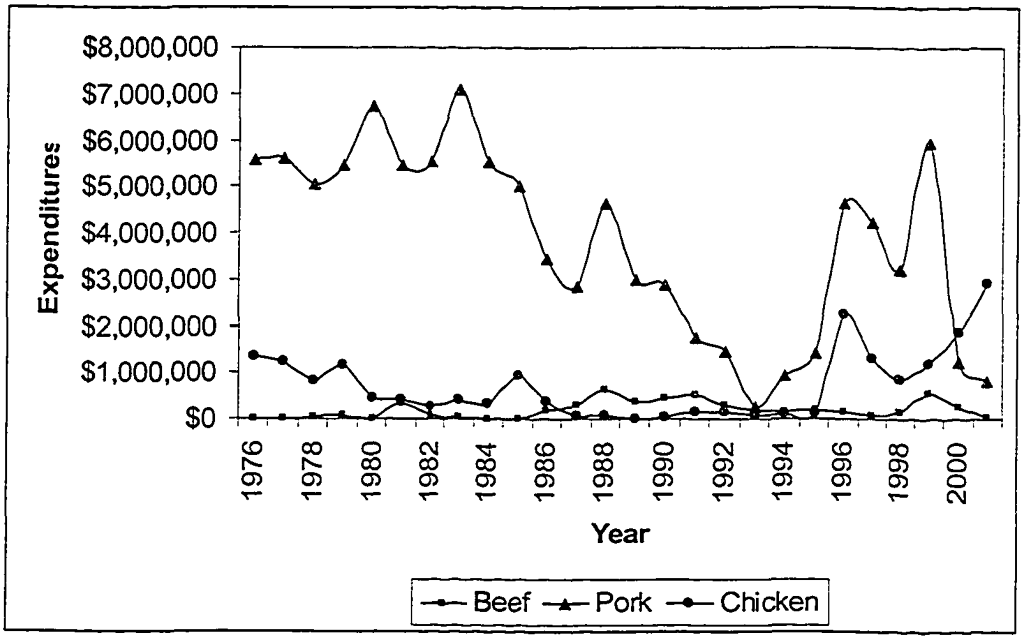
We include in the model expenditures on generic, brand and fast food restaurant advertising. Generic advertising is undertaken by producers and they normally fund these expenditures through check-off programs. We obtained these data from the annual reports of the national and the various provincial commodity groups. Brand and restaurant advertising which is undertaken by processors and fast food chains, respectively, was obtained from AC Nielsen. Figures 4-3, 4-4 and 4-5 show advertising expenditures by the meat industry in Canada.

Figure 4-3 Beef, pork and chicken generic advertising real expenditures (1981 dollars)



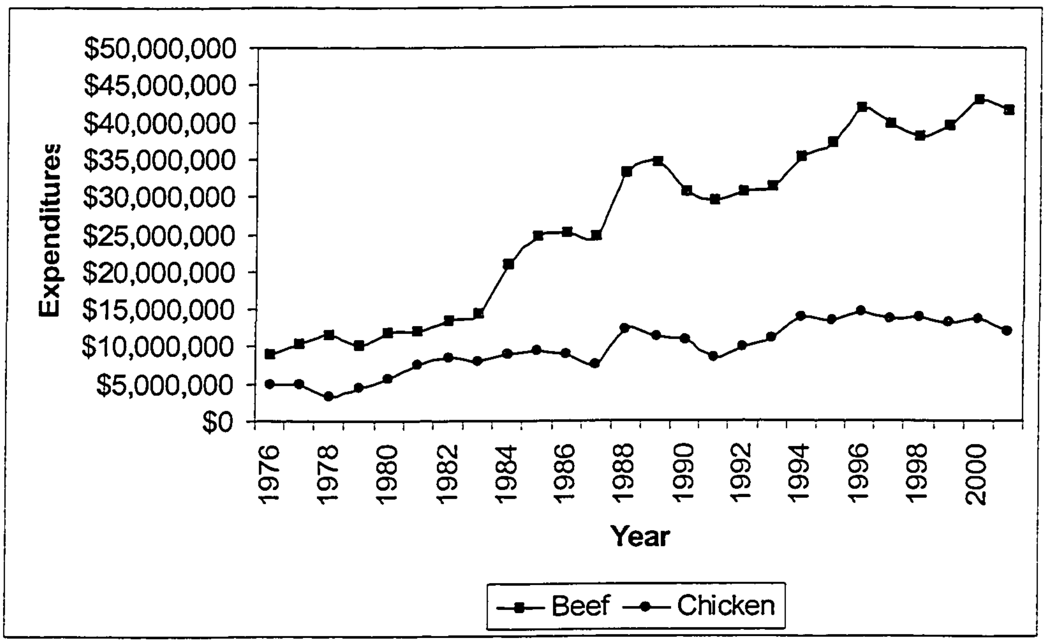

Source: Annual reports of the national and the various provincial commodity groups

Figure 4-4 Beef, pork and chicken brand advertising real expenditures (1981 dollars)




Source: AC Nielsen

Figure 4-5 Beef and chicken fast food restaurant advertising real expenditures (1981 dollars)

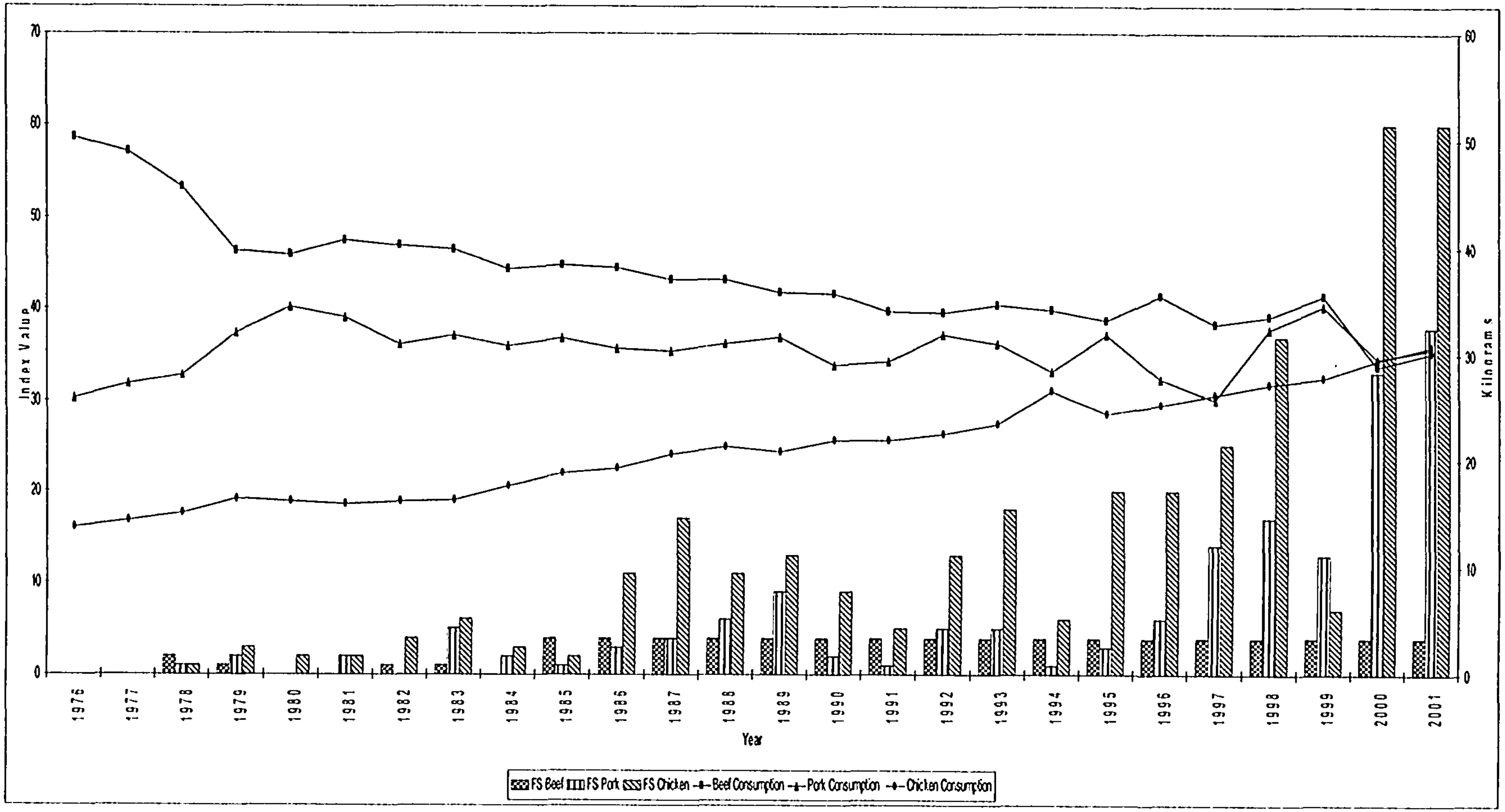



Source: AC Nielsen

Media indices are included to measure the impact of food safety and health concerns on aggregated Canadian meat demand. These media indices were obtained using the publications library of Dow Jones Interactive and take into account the number of articles published in Canada by quarter from 1976 to 2001. The FSI's are counts of the number of articles related to BSE and E. coli for beef, E. coli and Salmonella for pork, and E. coli and Salmonella for chicken. On the other hand, the HI's are net counts (positive – negative) of the number of articles linking consumption of each meat type (beef, pork, and chicken) with cancer, heart disease, and stroke. Figures 4-6 and 4-7 show the FSI's and the HI's, respectively.

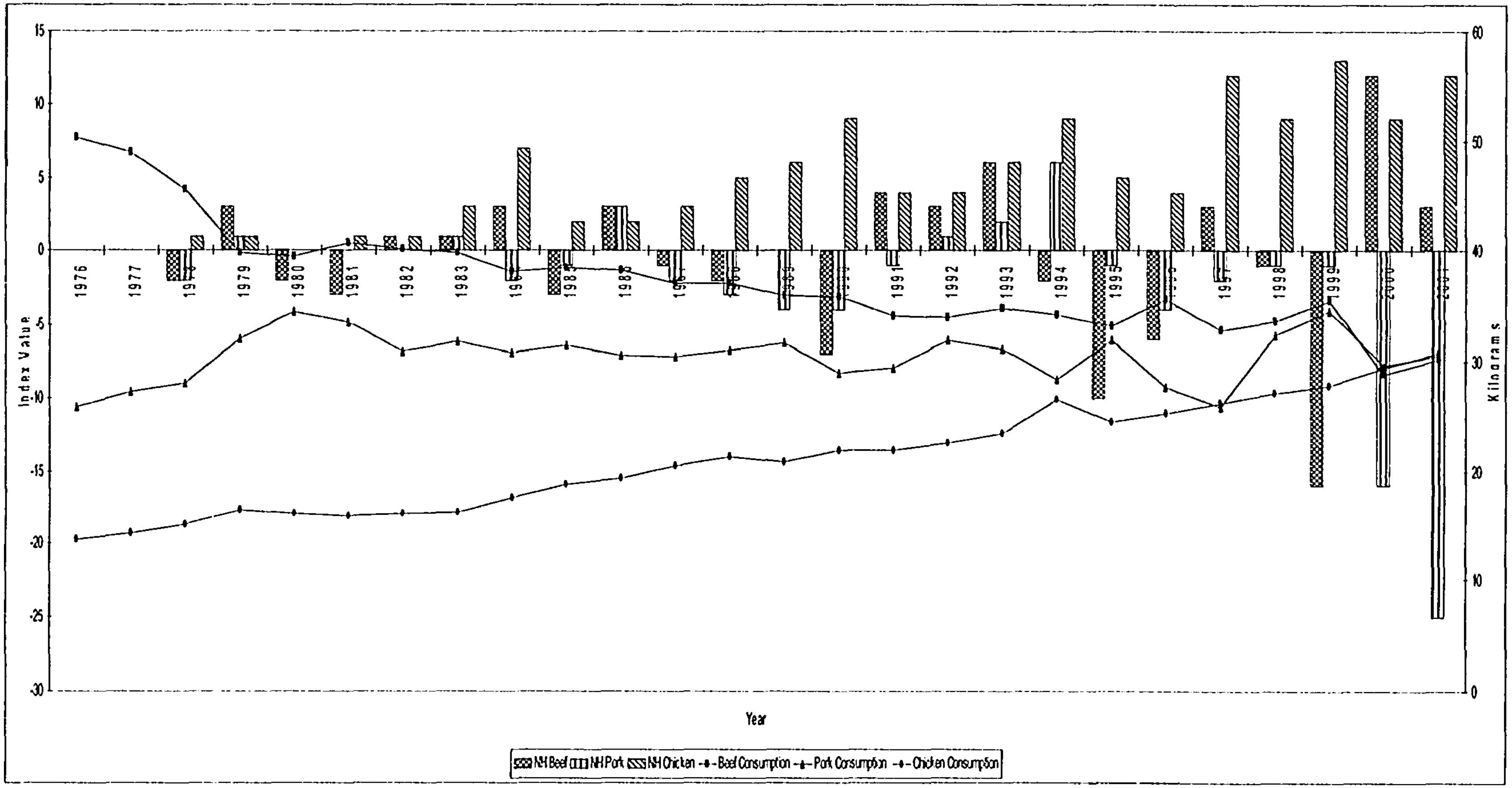
As stated in the second chapter of this thesis, social marketing programs should be considered in demand analysis because of the possible effects that they have on consumer decision making. It was decided that, because of the wide acceptance that the various Canadian Food Guides have and because they have been around for a considerable time,

Figure 4-6 Annual per capita disappearance of beef, pork and chicken, and the food safety indices



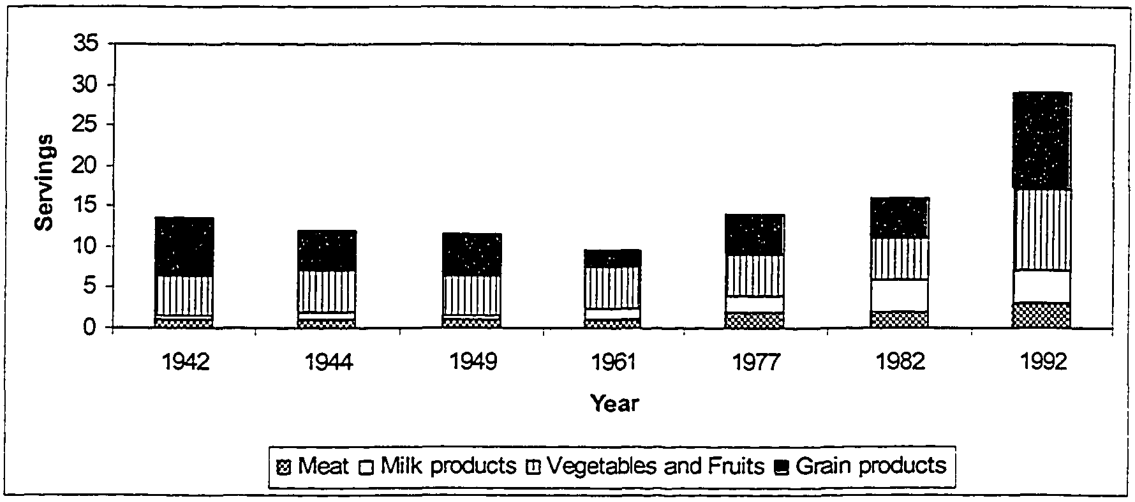

Source: Dow Jones Interactive, number of newspaper articles referring to BSE and E. coli for beef, E. coli and Salmonella for pork, and E. coli and Salmonella for chicken

Figure 4-7 Annual per capita disappearance of beef, pork and chicken, and the net health indices




Source: Dow Jones Interactive, net positive counts (positive – negative) of the number of newspaper articles linking consumption of each meat type (beef, pork and chicken) with cancer, heart disease, and stroke the recommendations made in the different food guides should be considered in this time series analysis. Considering all food guides, the number of recommended servings of the different food groups has been increasing over time (Figure 4-8).

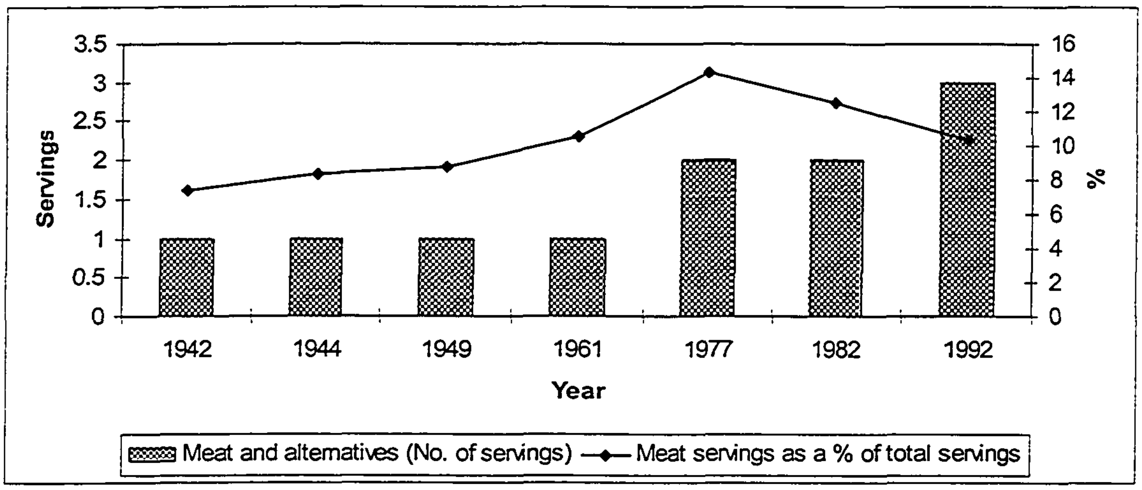
Figure 4-8 Recommended number of servings in the various Canadian Food Guides




Source: Health Canada (Canada's Food Guides From 1942 to 1992)

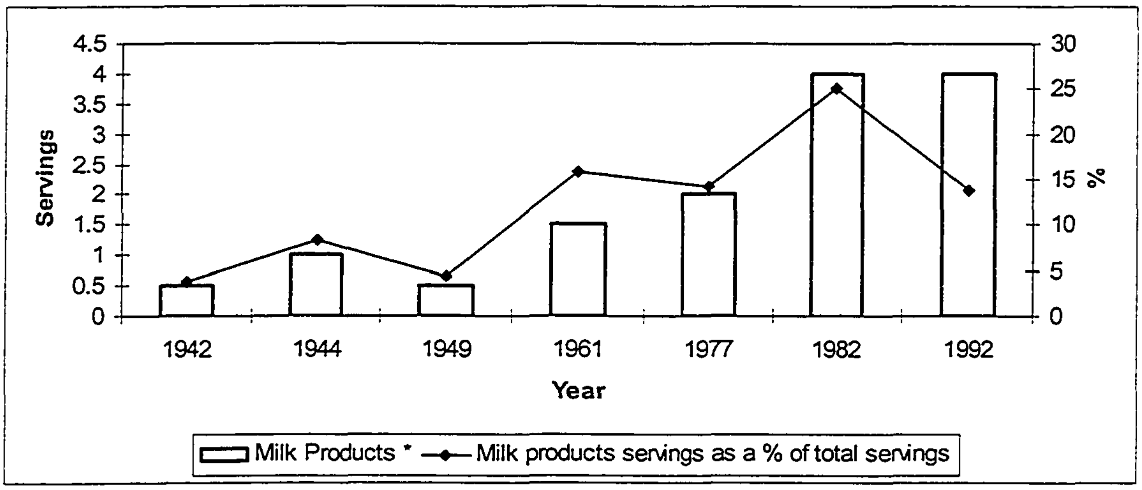
Taking a look at the individual food groups, we find that in all cases (meat and alternatives, milk products, vegetables and fruits, and grain products) the number of servings recommended in the various food guides has been increasing over the past number of years. The following figures offer some insights on this issue.

Figure 4-9 Number of recommended meat servings as a percentage of total servings recommended, various Canadian Food Guides



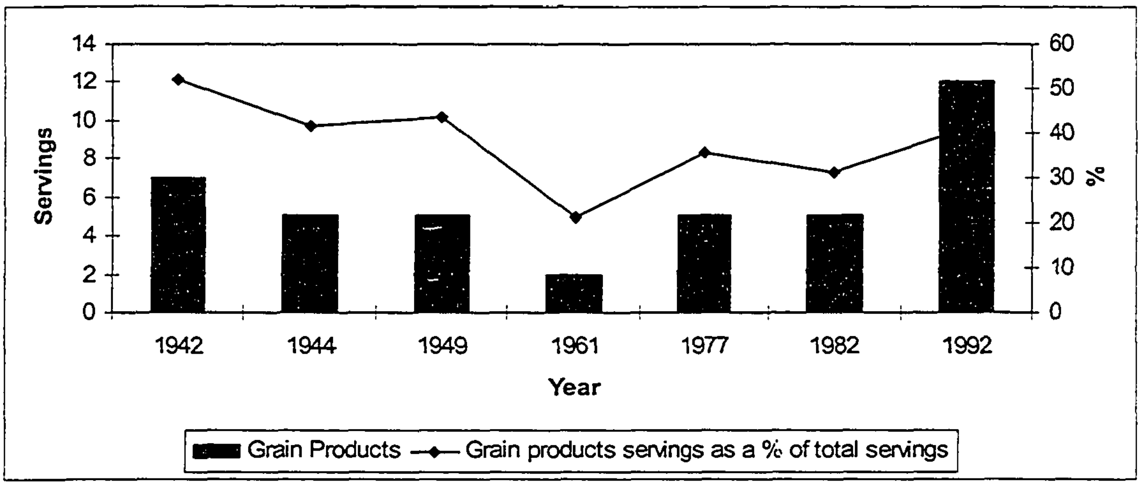

Source: Health Canada (Canada's Food Guides From 1942 to 1992)

Figure 4-10 Number of recommended milk products servings as a percentage of total servings recommended, various Canadian Food Guides



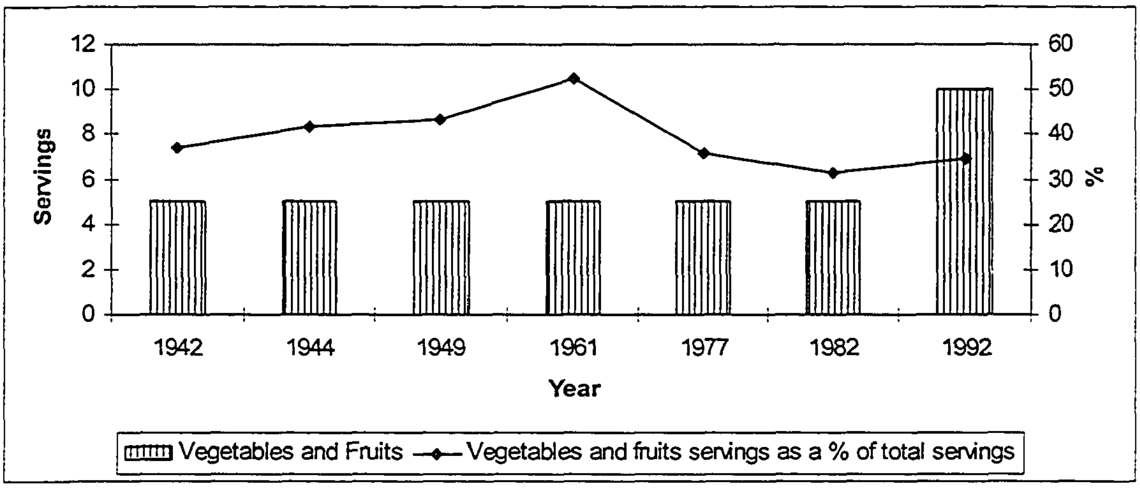

Source: Health Canada (Canada's Food Guides From 1942 to 1992)

Figure 4-11 Number of recommended grain products servings as a percentage of total servings recommended, various Canadian Food Guides




Source: Health Canada (Canada's Food Guides From 1942 to 1992)

Figure 4-12 Number of recommended vegetables and fruit servings as a percentage of total servings recommended, various Canadian Food Guides




Source: Health Canada (Canada's Food Guides From 1942 to 1992)

The recommendations made in successive Canadian Food Guides may have affected meat demand. Initially, it was found that the actual recommendations of meat servings have increased through time (as much as 3 times in 50 years), but calculating meat servings as a percentage of total servings showed a decreasing pattern in the sample period. From 1977 on the importance of meat servings relative to the total number of servings in the diet has declined. After this finding, it is especially interesting to include meat servings as a percentage of total servings in the estimation to see what has been the impact of the messages provided by the various food guides on Canadian meat demand. This variable is included in the first stage of the demand system.

All variables, but with the exception of advertising expenditures and the media indices are converted to a per capita basis. Since parameter estimates are not invariant to rescaling (Goddard and Cozzarin 1992; Christensen and Manser 1977), the variables are also scaled to 1.00 in the second quarter of 1989, in order to ease the convergence of the nonlinear demand system.

**4.3 Estimation Results**

TSP 4.5 is used for the estimation of the two-stage meat demand system. The first stage of the system is represented by a double log relationship. Double log relationships are frequently used at the first stage because they provide a model where the estimated parameters are the elasticity estimates. The equations are estimated simultaneously with substitutions of endogenous variables from one stage into the other stage. A number of lags and different cumulative aggregations were tested for the various information variables.

A number of regressions were run using the same basic model but restricting the coefficients for advertising and the media indices in the two stages of the demand system to zero. Likelihood ratio tests ($\lambda_{LR} = 2[\ln(L)_u - \ln(L)_r]$) were conducted to estimate the importance of the inclusion of such variables in the final model. We reject the null hypotheses that the food safety index, the health index, the two media indices together, and the various Canadian Food Guides have no effect on total expenditure on meats. We also reject the null hypotheses that generic advertising, brand advertising, restaurant advertising, the food safety indices, the health indices and both media indices together have no effect on the shares of beef and pork in the second stage. Across the two stages; from setting all advertising expenditures to zero, as well as the food safety indices, the health indices, and both media indices together (food safety and health), we reject the hypotheses that such inclusions have no effect on the demand system. Therefore, considering the interactions across the two stages, all advertising expenditures and all the indices should be retained in the final demand system. Table 4-1 presents the LR test statistics ($\lambda_{LR}$).

Table 4-1 Log-likelihood ratio test results for model specification

| Model | Log-likelihood | LR test statistics |
|---|---|---|
| **Original** | 867.818 | |
| Restricting | | |
| **FIRST ST** | | |
| All ADV | 866.528 | 2.580 |
| FS | 866.088 | 3.460 * |
| H | 861.432 | 12.772 *** |
| Media Indices | 859.605 | 16.426 *** |
| Food Guide | 865.569 | 4.498 ** |
| **SECOND ST** | | |
| Rest. GA | 853.757 | 28.122 *** |
| Rest. BA | 860.281 | 15.074 *** |
| Rest. RA | 856.682 | 22.272 *** |
| Media Indices | 841.555 | 52.526 *** |
| FS | 862.213 | 11.210 *** |
| H | 866.674 | 2.288 |
| Seasonality | 839.563 | 56.510 *** |
| Time | 854.769 | 26.098 *** |
| Including Dynamics | 805.904 | 123.828 *** |
| **BOTH STAGES** | | |
| All AVD | 817.700 | 100.236 *** |
| FS | 862.008 | 11.620 *** |
| H | 866.441 | 2.754 * |
| All Media | 839.284 | 57.068 *** |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.
(Chi-square critical values are 6.635 (1%), 3.841 (5%), and 2.706 (10%)

In order to estimate the system of equations, the equation for chicken was left out, since the shares of all the three meats have to sum to 1. Then the parameters of the chicken equation are recovered from the other equations in the system. Parameter estimates of the total expenditure function are given in Table 4-2. This first stage equation explained 88.64 percent of the variation in total expenditure on meats. The weighted average price coefficient is positive and significant at the 1% level, indicating inelasticity of aggregate demand for meat (beef, pork and chicken). The Food Safety Index for meats is negative and statistically significant (1%) at the first stage; food safety issues have negatively impacted total expenditures on meats in Canada. The Health Index is positive and significant (1%) at the first stage; this result was expected since a net index was used for the estimation. The addition of quarterly dummy variables detected seasonality; total expenditure on meats is significantly different in the first and third quarters of the year as compared to the fourth quarter. The sum of generic, brand and restaurant advertising for the three meats has a positive and significant (5%) effect on total expenditure; suggesting that industry efforts to increase consumption through marketing activities have been positive in aggregate. Interestingly, recommendations made in the different Canadian Food Guides have a negative and significant (1%) effect, suggesting that total expenditures on meats have, in fact, being affected by such recommendations.

Table 4-2 Nonlinear multiple regression estimates of the total expenditure function for meat consumption in Canada, 1978-2001

| Parameter | Estimate | t-statistic |
|---|---|---|
| **Intercept** | 5.164 *** | 8.724 |
| **Price** | 0.887 *** | 12.426 |
| **Income** | -0.251 *** | -3.921 |
| **Q1** | -0.027 *** | -2.559 |
| **Q2** | 0.013 | 1.300 |
| **Q3** | 0.028 *** | 2.746 |
| **Food Safety** | -0.001 *** | -3.722 |
| **Health** | 0.031 *** | 4.033 |
| **Food Guide** | -0.062 ** | -2.338 |
| **Total Exp (-1)** | 0.048 | 1.545 |
| **Advertising** | 0.002 ** | 2.154 |
| **Time** | 0.012 | 0.703 |
| D.W. | | 1.10546 |
| L.M. Heteroskedasticity test | | 9.144 |
| $R^2$ | | 0.886 |
| Number of observations | | 94 |
| Log-likelihood function value | | 867.818 |

Note: *** and ** indicate significance at the 1 and 5 percent level, respectively. Although only the parameter estimates for the first stage equation are reported in this table, the system was estimated simultaneously with the second stage equations. Parameter estimates for the second stage equations are reported in Appendix C.

The estimated parameters of the Generalized Box-Cox share equations are presented in Appendix C. The main purpose of this study is to determine the impact of prices, income and whether media messages about food safety and healthy eating awareness have had any effect on meat demand and to quantify such effect, as well as how effective industry efforts to increase consumption have been. A better understanding of these issues can be achieved looking directly at the elasticity estimates which take into account all the interactions among the different parameter estimates and finally give the impact of prices, advertising expenditures, and index values on quantity consumed. The own- and cross-elasticities for price, the three types of advertising, and the food safety and health indices associated with beef, pork and chicken consumption across the two stages and at the second stage of the demand system are shown from Table 4-3 to 4-13. Although the calculation of the elasticities at the mean is only a theoretically grounded methodology when estimating single linear equations (because for linear equations the mean is a data point through the fitted regression line), all the elasticity estimates of this thesis are calculated at the mean. For non-linear models, as is the case of this thesis, elasticities could be calculated at specific picked points in the data or at every single data point. Calculating elasticities at every data point could generate an important number of estimates and it could be onerous to deal with that many elasticities; that is why, for the purposes of this study, it was decided to calculate the elasticities at the mean.

### 4.3.1 Price Elasticities

Across the two stages of the demand system (Table 4-3), all own-price elasticities are negative and significant (1%). All cross-price elasticities are positive across the two stages of the demand system, and all are significant (1%) with the exception of the effect of beef prices on both pork and chicken. These results suggest substitutability among the meat products considered in this study. Considering the elasticities at the second stage (Table 4-4), only one cross-price elasticity has a significant (1%) but negative impact, pork price on beef consumption. This counterintuitive result is corrected when considering the two stages of the demand system. With respect to the own price elasticities, the three own-price elasticities (beef, pork and chicken) are more elastic at the second stage than across two-stages. Again, all own-price elasticity estimates are inelastic and negative in both cases; across two-stage and at the second stage.

Table 4-3 Across two-stage, own- and cross-price elasticities of demand for the Canadian meat market

| | Beef Price | Pork Price | Chicken Price |
|---|---|---|---|
| **Beef Q** | **-0.428** *** | 0.157 *** | 0.146 *** |
| | **[-7.821]** | [5.023] | [7.462] |
| **Pork Q** | 0.133 | **-0.363** *** | 0.138 *** |
| | [1.173] | **[-5.361]** | [4.407] |
| **Chicken Q** | 0.177 | 0.193 *** | **-0.463** *** |
| | [1.335] | [3.837] | **[-6.816]** |

Note: *** indicate significance at the 1 percent level.
Values in square brackets are t-statistics, bold values are own price elasticities.

Table 4-4 Second stage, own- and cross-price elasticities of demand for the Canadian meat market

| | Beef Price | Pork Price | Chicken Price |
|---|---|---|---|
| **Beef Q** | **-0.929** *** | -0.155 *** | -0.018 |
| | **[-14.931]** | [-10.758] | [-0.692] |
| **Pork Q** | -0.235 | **-0.593** *** | 0.017 |
| | [-1.264] | **[-18.640]** | [0.723] |
| **Chicken Q** | -0.198 | -0.041 | **-0.586** *** |
| | [-1.000] | [-0.807] | **[-12.793]** |

Note: *** indicate significance at the 1 percent level.
Values in square brackets are t-statistics, bold values are own price elasticities.

### 4.3.2 Generic Advertising Elasticities

Considering the interactions across the two stages (Table 4-5), the own-generic advertising elasticities are significant for beef and pork; increased promotional expenditures by beef and pork producer boards have a positive impact on beef and pork consumption, respectively. Also across the two stages, beef consumption is significantly (5%) but differently impacted by pork and chicken generic advertising; pork generic advertising decreases beef consumption while chicken generic advertising increases beef consumption. It is found that pork consumption is positively impacted by beef generic advertising (5%). The latter two significant cross positive impacts might be considered counterintuitive; beef producers do not advertise their product to increase pork consumption, neither do chicken producers to increase beef consumption. The significant own impacts for beef and pork generic advertising across the two stages of the demand system are consistent when considering the second stage elasticities (Table 4-6). The only significant (1%) cross effect at the second stage suggests that pork generic advertising elasticities not only increase own pork consumption, but also have a negative effect on beef consumption.

Table 4-5 Across two-stage, own- and cross-generic advertising elasticities of demand for the Canadian meat market

| | Beef G.ADV | Pork G. ADV | Chicken G.ADV |
|---|---|---|---|
| **Beef Q** | **0.005** ** | -0.052 ** | 0.003 ** |
| | **[2.299]** | [-2.395] | [2.003] |
| **Pork Q** | 0.004 ** | **0.258** *** | -0.002 |
| | [1.995] | **[3.430]** | [-0.768] |
| **Chicken Q** | 0.003 | 0.094 | **0.005** |
| | [1.320] | [1.251] | **[0.972]** |

Note: *** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics, bold values are own generic advertising elasticities

Table 4-6 Second stage, own- and cross-generic advertising elasticities of demand for the Canadian meat market

| | Beef G.ADV | Pork G. ADV | Chicken G.ADV |
|---|---|---|---|
| **Beef Q** | **0.003** * | -0.054 *** | 0.001 |
| | **[1.777]** | [-2.542] | [1.002] |
| **Pork Q** | 0.003 | **0.257** *** | -0.004 |
| | [1.381] | **[3.415]** | [-1.429] |
| **Chicken Q** | 0.001 | 0.092 | **0.003** |
| | [0.542] | [1.229] | **[0.672]** |

Note: *** and * indicate significance at the 1 and 10 percent level, respectively.
Values in square brackets are t-statistics, bold values are own generic advertising elasticities.

### 4.3.3 Brand Advertising Elasticities

Beef brand advertising efforts by processors positively impact (5%) own beef consumption across the two stages of the GBC system (Table 4-7). Also across the two stages, chicken brand advertising has a positive and significant (10%) impact on chicken consumption. Unexpectedly, beef brand advertising positively impacts both pork and chicken consumption. The second stage own-brand advertising elasticity for beef is positive and significant at the 10 percent level (Table 4-8), showing consistency with the across two-stage estimate for beef. Nevertheless, we find a couple of unexpected positive signs; the impact of beef and pork brand advertising on chicken consumption.

Table 4-7 Across two-stage, own- and cross-brand advertising elasticities of demand for the Canadian meat market

| | Beef B.ADV | Pork B. ADV | Chicken B.ADV |
|---|---|---|---|
| **Beef Q** | **0.005** ** | 0.001 | 0.001 |
| | **[2.287]** | [0.839] | [1.086] |
| **Pork Q** | 0.004 ** | **0.004** | 0.003 |
| | [2.217] | **[1.148]** | [1.610] |
| **Chicken Q** | 0.006 *** | 0.009 ** | **0.010** * |
| | [2.717] | [2.104] | **[1.820]** |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.
Values in square brackets are t-statistics, bold values are own brand advertising elasticities.

Table 4-8 Second stage, own- and cross-brand advertising elasticities of demand for the Canadian meat market

| | Beef B.ADV | Pork B. ADV | Chicken B.ADV |
|---|---|---|---|
| **Beef Q** | **0.003** * | -0.001 | -0.001 |
| | **[1.670]** | [-1.335] | [-1.101] |
| **Pork Q** | 0.002 | **0.002** | 0.001 |
| | [1.454] | **[0.667]** | [0.816] |
| **Chicken Q** | 0.004 ** | 0.008 * | **0.009** |
| | [1.991] | [1.733] | **[1.502]** |

Note: ** and * indicate significance at the 5 and 10 percent level, respectively.
Values in square brackets are t-statistics, bold values are own brand advertising elasticities.

### 4.3.4 Restaurant Advertising Elasticities

The across two-stage beef advertising restaurant elasticity indicates a significant (10%) and positive own effect of advertising expenditures on beef consumption (Table 4-9); the fast food restaurant industry has had an impact on beef sales through its promotional marketing strategies. Fast food industry efforts to promote their products have also positively impacted (5%) chicken consumption; an unexpected impact of the fast food restaurants' marketing strategy. At the second stage only (Table 4-10), chicken restaurant advertising negatively and significantly (5%) impacts pork consumption. As with the estimates across the two stages; chicken restaurant advertising significantly (1%)

increases beef consumption, and beef restaurant advertising significantly (10%) increases chicken consumption. These two latter elasticity estimates display unexpected signs but may reflect the fact that fast food chains increasingly offer multiple products and not only beef-based meals. (i.e. McDonald's offers the Chicken McGrill, Crispy Chicken and McChicken sandwiches; Wendy's offers the Ultimate Chicken Grill, Spicy Chicken Fillet and Homestyle Chicken Fillet sandwiches; Burger King offers the Tendercrisp, Chicken Whopper and Original Chicken sandwiches, to name a few. They also offer non-burger chicken meals such as strips and nuggets).

Table 4-9 Across two-stage, own- and cross-restaurant advertising elasticities of demand for the Canadian meat market

| | Beef R.ADV | Pork R. ADV | Chicken R.ADV |
|---|---|---|---|
| **Beef Q** | **0.008 *** | — | 0.079 *** |
| | **[1.735]** | — | [3.298] |
| **Pork Q** | 0.000 | — | -0.246 |
| | [-0.042] | — | [-1.617] |
| **Chicken Q** | 0.040 ** | — | **0.020** |
| | [1.999] | — | **[0.299]** |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.
Values in square brackets are t-statistics, bold values are own restaurant advertising elasticities.

Table 4-10 Second stage, own- and cross-restaurant advertising elasticities of demand for the Canadian meat market

| | Beef R.ADV | Pork R. ADV | Chicken R.ADV |
|---|---|---|---|
| **Beef Q** | **0.006** | — | 0.077 *** |
| | **[1.300]** | — | [3.162] |
| **Pork Q** | -0.002 | — | -0.248 * |
| | [-0.315] | — | [-1.628] |
| **Chicken Q** | 0.038 * | — | **0.019** |
| | [1.905] | — | **[0.275]** |

Note: *** and * indicate significance at the 1 and 10 percent level, respectively.
Values in square brackets are t-statistics, bold values are own restaurant advertising elasticities.

### 4.3.5 Food Safety Elasticities

The Food Safety Indices are counts of the number of newspaper articles related to BSE and E. coli for beef, E. coli and Salmonella for pork, and E. coli and Salmonella for chicken. Considering across two-stage (Table 4-11) and second stage (Table 4-12) elasticity estimates; the Food Safety Indices have no own effect. Canadians might have considered food safety issues as external, especially BSE, and might have not reacted to such issues when allocating expenditures among the different meats. A closer look at the newspaper articles used to build the food safety indices reveals that many food safety occurrences were actually registered outside Canada (i.e. the BSE crisis in Europe and the E. coli scare at Jack in the Box in the US) Nevertheless, there are negative and significant (5%) cross effects of pork and chicken food safety issues on beef demand. There is the possibility that food safety issues relating to E. coli might have caused confusion among consumers; even when E. coli had to do with contamination of pork or chicken many newspaper articles referred to E. coli as "hamburger disease". There is also another significant (5%) cross effect of pork safety issues on chicken consumption.

Table 4-11 Across two-stage, own- and cross food safety elasticities of demand for the Canadian meat market

| | Beef FS | Pork FS | Chicken FS |
|---|---|---|---|
| **Beef Q** | **0.001** | -0.001 ** | -0.003 ** |
| | **[0.415]** | [-2.266] | [-1.958] |
| **Pork Q** | -0.028 | **-0.002** | 0.002 |
| | [-1.503] | **[-0.729]** | [0.862] |
| **Chicken Q** | -0.019 | -0.004 ** | **0.017** |
| | [-1.014] | [-2.327] | **[1.359]** |

Note: ** indicate significance at the 5 percent level.
Values in square brackets are t-statistics, bold values are own food safety elasticities.

Table 4-12 Second stage, own- and cross food safety elasticities of demand for the Canadian meat market

| | Beef FS | Pork FS | Chicken FS |
|---|---|---|---|
| **Beef Q** | **0.002** | 0.000 | -0.002 |
| | **[1.359]** | [0.947] | [-1.314] |
| **Pork Q** | -0.027 | **-0.001** | 0.003 |
| | [-1.460] | **[-0.444]** | [1.221] |
| **Chicken Q** | -0.018 | -0.003 * | **0.018** |
| | [-0.967] | [-1.873] | **[1.433]** |

Note: * indicate significance at the 10 percent level.

Values in square brackets are t-statistics, bold values are own food safety elasticities.

### 4.3.6 Health Elasticities

The Health Indices are net counts (positive – negative) of the number of newspaper articles linking consumption of each meat type (beef, pork, and chicken) with cancer, heart disease, and stroke. Across the two stages (Table 4-13), the beef health index displays an interesting and significant (5%) positive sign; the beef net health index has positively affected beef consumption. The increasing popularity of the low carbohydrate diets (i.e. Dr. Atkins' New Diet Revolution, Protein Power, The Scarsdale Diet, The Zone and Sugar Busters!) at the end of the 1990's and beginning of the 2000's linked high protein diets (rich in beef and other meats) to weight loss regimes. Considering the increasing overweight and obesity rates in Canada and the U.S., and people's efforts to lose some pounds, diets have been signaled to be near to an obsession in North America; a trend that has possibly impacted beef consumption in Canada. Pork consumption has also been positively impacted by increased information about the healthiness of pork. These results suggest that information about the different meats and some health issues play an important role in consumer purchasing decisions. The cross effects display the unexpected sign; some of the counterintuitive signs are related to the effect of pork net health information on chicken and the effect of chicken net health information on pork consumption. This latter situation may be a consequence of the efforts that the pork industry has made in showcasing pork as the 'new white meat', possibly encouraging consumers to consider pork and chicken as very similar to one another. Table 4-14 shows health elasticities at the second stage.

Table 4-13 Across two-stage, own- and cross health elasticities of demand for the Canadian meat market

| | Beef H | Pork H | Chicken H |
|---|---|---|---|
| **Beef Q** | **0.032** ** | 0.018 * | 0.028 *** |
| | **[2.492]** | [1.828] | [2.735] |
| **Pork Q** | 0.019 | **0.081** ** | 0.051 *** |
| | [0.375] | **[2.034]** | [2.966] |
| **Chicken Q** | 0.053 | 0.092 *** | **-0.014** |
| | [0.909] | [4.048] | **[-0.225]** |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.
Values in square brackets are t-statistics, bold values are own net health elasticities.

Table 4-14 Second stage, own- and cross health elasticities of demand for the Canadian meat market

| | Beef H | Pork H | Chicken H |
|---|---|---|---|
| **Beef Q** | **-0.002** | -0.016 ** | -0.006 |
| | **[-0.212]** | [-2.154] | [-0.803] |
| **Pork Q** | -0.006 | **0.055** | 0.026 |
| | [-0.121] | **[1.336]** | [1.436] |
| **Chicken Q** | 0.028 | 0.066 *** | **-0.039** |
| | [0.489] | [2.580] | **[-0.647]** |

Note: *** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics, bold values are own net health elasticities.

### 4.4 Simulation Results

One of the advantages of using time series data is that it allows the researcher to do simulations. Using the base model we can shock a variable to see what happens with the

Canadian meat market. Some simulations were run, all of them at mean values, in order to predict the effects of:

- Increased pork prices;
- Increased chicken prices;
- Increased beef generic advertising expenditures;
- Increased pork generic advertising expenditures
- Increased beef brand advertising expenditures;
- Increased beef restaurant advertising expenditures;
- Increased net beef health information;
- Decreased net pork health information;
- Decreased net chicken health information;

Simulation results are presented in Table 4-15. Relative prices have had an impact on beef consumption, the first two shocks show that if pork and chicken prices had been 10 percent higher, per capita beef consumption would have been around 1 more kilogram (increased pork price) and 540 grams (increased chicken price) per quarter.

The next shock pictures an increase of the advertising expenditures made by beef producers in Canada. If beef generic advertising expenditures had been 25 percent higher, quarterly per capita beef consumption would have been around 77 grams higher, and quarterly pork and chicken disappearance would have decreased by 15 and 68 grams, respectively. From 1992 to 2001, average quarterly beef generic advertising expenditures were $1,181,363, an increase of 25 percent would represent that advertising expenditures increased by $295,341.

Table 4-15 Simulation results, changes in per capita beef, pork and chicken disappearance due to changes in various variables

| Average Quarterly Changes in Beef, Pork and Chicken Consumption Due to Changes in: | Beef kg | Pork kg | Chicken kg |
|---|---|---|---|
| Pork Price (10% increase) | 1.0628 | -1.0902 | -0.1149 |
| Chicken Price (10% increase) | 0.5403 | -0.2158 | -0.6989 |
| Beef Generic Advertising (25% increase) | 0.0769 | -0.0147 | -0.0682 |
| Pork Generic Advertising (25% decrease) | 0.0425 | -0.0637 | 0.0212 |
| Beef Brand Advertising (25% increase) | 0.0562 | -0.0259 | -0.0325 |
| Beef Restaurant Advertising (25% increase) | 0.1218 | -0.3600 | 0.2693 |
| Net Beef Health Information (50% increase) | 0.3287 | -0.4760 | 0.4861 |
| Net Pork Health Information (50% decrease) | 1.9664 | -1.1168 | -1.5879 |
| Net Chicken Health Information (50% decrease) | 0.0407 | -1.0404 | -0.5891 |

On the other hand, if pork generic advertising expenditures had been 25 percent lower, quarterly per capita beef and chicken consumption would have been 43 and 21 grams higher, respectively. Results of this simulation suggest that marketing efforts by pork producers have worked in their favor. Average quarterly generic advertising expenditures by pork producers, from 1992 to 2001, were around $765,000.

If beef brand advertising or advertising undertaken by beef processors had been 25 percent higher, quarterly per capita beef consumption would have been 56 grams higher, while pork and chicken consumption would have been 26 and 33 grams lower, respectively. The average quarterly investment in advertising made by beef processors from 1992 to 2001 was $93,093.

The fast food restaurant industry invests a considerable amount of money every year aimed at inducing consumers to buy their products. Although these investments have not the objective of increasing beef consumption per se, they do have a significant effect on beef consumption. From 1992 to 2001, the average quarterly investment in beef restaurant advertising was around $17 million dollars. If beef restaurant advertising expenditures had been 25 percent higher, quarterly per capita beef consumption would have been 122 grams higher, while quarterly per capita pork consumption would have been 360 grams lower, and quarterly per capita chicken consumption would have been almost 270 grams higher. The positive impact on chicken consumption may be associated with the fact that traditional beef fast food outlets such as McDonald's, Wendy's or Burger King have increasingly included chicken products on their menus.

With the increase of awareness about the possible health benefits or risks from consuming meat in recent times, health information has played an important role in consumer purchasing decisions. Some newspaper articles have showcased the health benefits from eating a certain kind of meat; signaling that they have low saturated fat content or that they are a good source of a certain nutrient. At the same time, a number of newspaper articles have reported findings on medical research that signal an association between meats and certain diseases. If the beef net health index increased by 50 percent as a result of a decreased number of negative articles about beef and health, while the number of positive articles remained constant, quarterly beef disappearance would have been 329 grams higher. If the pork and chicken net health indices decreased by 50 percent, as a result of a decreased number of positive articles about pork and chicken and health, while the number of negative articles remained constant, beef consumption would have been 1.97 kilograms and 41 grams higher, respectively.

## 4.5 Comparison to Previous Studies

Table 4-16 offers an insightful look at the estimation results of this thesis and some other studies carried out using Canadian time series data. The own-price elasticities estimated using the model specification of this thesis are quite similar to previous elasticity estimations. They are close to the average, specially the own-price elasticity for chicken, and all of them are between the range of minimum and maximum previously estimated own-price elasticities. It is also noticeable that studies on the Canadian meat market have estimated beef demand as being more price inelastic beginning in 1992.

Table 4-16 Own-price elasticities for beef, pork and chicken, a comparison to various studies on Canadian meat demand

| Study | Functional Form | Commodity | | |
|---|---|---|---|---|
| | | Beef | Pork | Chicken |
| Trypos and Tryphonopoulus (1973) | Linear | -0.521 | -1.049 | -0.870 |
| Hassan and Katz (1975) | Log-Log | -0.767 | -0.955 | -0.564 |
| Hassan and Johnson (1979a) | Box-Cox | -0.453 | -0.836 | -0.732 |
| Young (1987) | Box-Cox | -0.480 | -0.660 | -0.470 |
| | Log-Log | -0.430 | -0.670 | -0.280 |
| | Linear | -0.310 | -0.550 | -0.220 |
| | Linear-Log | -0.420 | -0.660 | -0.300 |
| Alston and Chalfant (1991) | Rotterdam | -0.660 | -0.740 | -0.740 |
| | Linear | -0.960 | -0.810 | -0.480 |
| | Log-Log | -0.840 | -0.790 | -0.580 |
| | LA/AIDS | -1.040 | -0.840 | -0.620 |
| Chalfant, Grey and White (1991) | LA/AIDS | -0.403 | -0.591 | -0.769 |
| Chen and Veeman (1991) | AIDS | -0.770 | -0.820 | -0.950 |
| Reynolds and Goddard (1991) | LA/AIDS | -0.736 | -0.676 | -0.334 |
| Goddard and Cozzarin (1992) | Translog | -1.080 | -0.100 | -0.320 |
| | AIDS | -1.130 | -0.020 | -0.260 |
| Moschini and Vissa (1993) | Rotterdam | -0.837 | -0.635 | -0.422 |
| Eales (1996) | AIDS | -0.810 | -0.860 | -0.450 |
| Xu and Veeman (1996) | AIDS | -0.797 | -0.694 | -0.412 |
| | Rotterdam | -0.799 | -0.649 | -0.329 |
| Goddard et al (2004) | Translog | -0.455 | -0.154 | -0.602 |
| | AIDS | -0.542 | -0.262 | -0.631 |
| | GBC | -0.263 | -0.475 | -0.412 |
| **Average** | **All** | -0.674 | -0.630 | -0.511 |
| Largest | | -1.130 | -1.049 | -0.950 |
| Smallest | | -0.263 | -0.262 | -0.220 |
| Lomeli (2004) | GBC | -0.428 *** | -0.363 *** | -0.463 *** |

Note: *** indicate significance at the 1 percent level.

Further comparisons of this study to previous work need to consider studies carried out not only in Canada but also in other parts of the world, such as the US, the UK and Australia, since Canadian studies on the impact of information variables on meat demand are scarce. First of all, most of the studies on the impact of information variables on meat demand have considered the advertising investments undertaken by the various commodity groups. Table 4-17 shows some of these studies. Most of the studies considering generic advertising in meat demand analysis use expenditures as the variable to be included in the model. Table 4-17 shows that it is not uncommon to find generic advertising elasticities displaying counterintuitive signs (e.g. beef generic advertising reducing beef consumption). Although it is complicated to compare elasticities across studies, the magnitude of this thesis estimates are similar to results of earlier studies. It is harder to interpret advertising elasticities than price elasticities because variable specification differs greatly across advertising studies. For prices, for example, it is rarely an option to lag or cumulate the data, while the same is a common but not systematic practice in advertising variables.

Table 4-17 Own-generic advertising elasticities for beef, pork and chicken, a comparison to various studies

| | | | Commodity | | |
|---|---|---|---|---|---|
| Study | Country | Functional Form | Beef | Pork | Chicken |
| Goddard and Cozzarin (1992) | Canada | Translog | -0.00100 | -0.00020 | 0.00700 |
| | | AIDS | -0.00010 | 0.00110 | 0.00060 |
| Brester and Schroeder (1995) | US | Rotterdam | 0.00600 | -0.00050 | n/a |
| Piggott et al (1996) | Australia | Log-Log | 0.03100 | 0.00850 | n/a |
| | | AIDS | 0.01570 | 0.01220 | n/a |
| Kinnucan et al (1997) | US | Rotterdam | 0.00113 | 0.00001 | n/a |
| Cranfield and Goddard (1999) | Canada | | 0.00001 | n/a | n/a |
| | US | | 0.01100 | n/a | n/a |
| Herrmann, Thompson and Krischik-Bautz (2002) | Germany | Single equation | 0.04200 | n/a | n/a |
| Boetel and Liu (2003) | US | AIDS | -0.00004 | 0.00670 | n/a |
| Goddard et al (2004) | Canada | Translog | -0.00300 | 0.01200 | 0.05500 |
| | | AIDS | 0.02000 | 0.06000 | 0.01700 |
| | | GBC | 0.00600 | 0.39300 | 0.12700 |
| Lomeli (2004) | Canada | GBC | 0.00500 ** | 0.25800 *** | 0.00500 |

Note: *** and ** indicate significance at the 1 and 5 percent level, respectively.

Brand advertising has normally been found to impact meat consumption in a more important way than generic advertising. In fact, Cranfield and Goddard (1999) state that, for the case of both Canada and the US, the impact of generic advertising on demand is smaller than that of branded advertising. The elasticity estimates obtained in this thesis are similar for both generic and brand advertising. Moreover, the estimate for the own-brand advertising elasticity for beef demand in Canada is similar to what Cranfield and Goddard (1999) found (Table 4-18).

Table 4-18 Own-brand advertising elasticities for beef, pork and chicken, a comparison to various studies

| Study | Country | Functional Form | Commodity | | |
|---|---|---|---|---|---|
| | | | Beef | Pork | Chicken |
| Brester and Schroeder (1995) | US | Rotterdam | 0.007 | 0.033 | 0.047 |
| Cranfield and Goddard (1999) | Canada | | 0.004 | n/a | n/a |
| | US | | 0.09 | n/a | n/a |
| Goddard et al (2004) | Canada | Translog | 0.007 | 0.015 | 0.019 |
| | | AIDS | -0.007 | 0.010 | 0.010 |
| | | GBC | 0.012 | 0.034 | 0.012 |
| Lomeli (2004) | Canada | GBC | 0.005 ** | 0.004 | 0.010 * |

Note: ** and * indicate significance at the 5 and 10 percent level, respectively.

Fast food restaurant advertising elasticites have not been commonly estimated before. A Canadian study is the only one to offer some insights into the matter (Goddard et al., 2004). Comparison to this study is especially useful because the data base used for the estimation purposes of this thesis is the same used by Goddard et al. (2004). Furthermore, the GBC functional form is one of the functional forms used in that study. The results are close but differ because for the estimation purposes of this thesis, it was also included a health index, while Goddard et al. (2004) did not use such an index. Table 4-19 displays the restaurant elasticity estimates for the Canadian meat market.

Table 4-19 Own-restaurant advertising elasticities for beef, pork and chicken, a comparison to various studies

| Study | Country | Functional Form | Commodity | | |
|---|---|---|---|---|---|
| | | | Beef | Pork | Chicken |
| Goddard et al (2004) | Canada | Translog | 0.106 | n/a | 0.115 |
| | | AIDS | 0.070 | n/a | 0.119 |
| | | GBC | 0.009 | n/a | -0.007 |
| Lomeli (2004) | Canada | GBC | 0.008 * | n/a | 0.020 |

Note: * indicate significance at the10 percent level.

The use of information indices in food demand systems has received increasing attention since the mid- late-nineties. This increased popularity has to do with the fact that in the late 1980's and early 1990's both food safety incidences (e.g. BSE) and health concerns (e.g. diet cholesterol) started being more important in the collective conscious. The problem with information indices is that it is even less appropriate to compare elasticity estimates among studies because the construction of such indices differs greatly across studies. The difference starts when building the index (i.e. medical journals or newspapers, counts or net indices, current or lagged, single commodity indices or a food index) and continues when the researcher takes the decision about how to include them in the demand system (i.e. shifter, translating, scaling). Nevertheless, a look at previous studies is believed to be an asset rather than a liability for the purposes of this thesis. Tables 4-20 and 4-21 show a comparison to previous elasticities for food safety and health indices, respectively.

Table 4-20 Food safety elasticities for beef, pork and chicken, a comparison to various studies

| | | | Commodity | | |
|---|---|---|---|---|---|
| Study | Country | Functional Form | Beef | Pork | Chicken |
| Burton and Young (1996) | UK | AIDS | -0.0450 | 0.0160 .+ | 0.0010 .+ |
| Strak (1998) | UK | AIDS | -0.0049 | 0.0020 .+ | n/a |
| Flake and Patterson (1999) | US | AIDS | -0.0130 | 0.0140 .+ | 0.0140 .+ |
| Herrmann, Thompson and Krischik-Bautz (2002) | Germany | Single equation | -0.0740 | n/a | n/a |
| Piggott and Marsh (2004) | US | G-AIDS | -0.0144 | -0.0131 | -0.0250 |
| Goddard et al (2004) | Canada | Translog | 0.0010 | 0.0070 | -0.0050 |
| | | AIDS | 0.0030 | 0.0110 | -0.0230 |
| | | GBC | -0.0030 | 0.0030 | -0.0080 |
| Lomeli (2004) | Canada | GBC | 0.0010 | -0.0020 | 0.0170 |

Note: + indicates the cross food safety elasticity of a beef food safety index with respect to other meat.

Table 4-21 Health elasticities for beef, pork and chicken, a comparison to various studies

| | | | Commodity | | |
|---|---|---|---|---|---|
| Study | Country | Functional Form | Beef | Pork | Chicken |
| Kinnucan et al (1997) | US | Rotterdam | -0.68100 | -0.19500 | 1.65900 |
| Flake and Patterson (1999) | US | AIDS | -0.06300 | 0.02000 | -0.15800 |
| Boetel and Liu (2003) | US | AIDS | -0.03680 | 0.01483 | 0.17032 |
| Lomeli (2004) | Canada | GBC | 0.03200 ** | 0.08100 ** | -0.01400 |

Note: ** indicate significance at the 5 percent level.

With respect to the comparison of food safety elasticities, most studies have been carried out in Europe. The BSE crisis has fostered the interest of industries, governments and academia in this matter and this interest has resulted in attempts to quantify the actual impacts of the crisis on the various meat markets. The common finding has been that beef safety issues negatively impact own consumption and increase consumption of other meats. For the purposes of this thesis, a food safety index was constructed for each of the three meats included in the demand analysis, and it would be closer to what Piggott and Marsh (2004) did in their study. Using the model specification of this thesis, the results indicate that food safety issues have not impacted meat consumption in Canada.

Health issues have been included in food demand analysis, too. The increased preoccupation of people about eating healthier is believed to have impacted food demand and some studies (Kinnucan et al., 1997; Flake and Patterson, 1999; Boetel and Liu, 2003) have found that it, in fact, did. It is worth noting that the differences in signs rise from how the indices were built. In this thesis a net positive information index was used for the case of health and, as such, the elasticities display the expected direction of the impacts. Although the comparison is not as insightful as one would like it to be because of the differences in constructing the index, it is useful to point out that the impact of an information variable, health in this case, has the magnitude that one would consider in line with previous studies.

### 4.6 Summary

Estimation results of the time series data indicate that not only prices but also information variables play a significant role when considering aggregate data on the

Canadian meat market, impacting consumers' purchasing decisions. This chapter specifically addresses the first objective of the present thesis; to determine the impact of traditional economic variables (prices and income) and information variables (generic advertising, brand advertising, restaurant advertising, food safety issues and health concerns) on Canadian meat demand.

Some simulations offer valuable information about what would happen if a specific variable is shocked. These simulations use the model estimated to predict such impacts. Finally, a comparison to previous studies provides a look at what has been found before. The comparison shows that, in general, the results of this thesis are in line with previous findings.

Table 4-22 shows a summary of the results of this thesis; the income elasticities and the own elasticities for price, generic advertising, brand advertising, fast food restaurant advertising, food safety and health.

Table 4-22 Summary of elasticity estimates

| | Income | Price | G ADV | B ADV | R ADV | Food Safety | Health |
|---|---|---|---|---|---|---|---|
| Beef Q | 1.103 *** | -0.428 *** | 0.005 ** | 0.005 ** | 0.008 * | 0.001 | 0.032 ** |
| | [12.879] | [-7.821] | [2.299] | [2.287] | [1.735] | [0.415] | [2.492] |
| Pork Q | 0.811 *** | -0.363 *** | 0.258 *** | 0.004 | n/a | -0.002 | 0.081 ** |
| | [4.490] | [-5.361] | [3.430] | [1.148] | n/a | [-0.729] | [2.034] |
| Chicken Q | 0.825 *** | -0.463 *** | 0.005 | 0.010 * | 0.020 | 0.017 | -0.014 |
| | [4.638] | [-6.816] | [0.972] | [1.820] | [0.299] | [1.359] | [-0.225] |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.
Values in square brackets are t-statistics.

The results obtained in the time series estimation of this thesis are valuable because the model used takes into account not only the traditional economic variables but also a wide range of information variables that are proven to impact consumption choices. It is found that those information variables have an effect on consumption and, as such, should be included in demand models in order to get better estimates of the demand for meat in Canada.

# Chapter 5

# Cross Sectional Results

## 5.1 Introduction

The second estimation carried out in this thesis makes use of micro- or consumer level data. The aim is to provide an insight into the robustness of the estimation results when using different kinds of data. In chapter four we provided results from the estimation using aggregate data. In the present chapter the results from the cross sectional estimation are outlined. Chapter six highlights similarities and differences between the results from the two estimations and provides comments concerning the estimation exercise carried out in this thesis.

## 5.2 Cross Sectional Data

The main data sources for the cross sectional estimation of this thesis are the 1996 and 2001 Food Expenditure Surveys (FES). Including the 2001 FES, 18 surveys have been carried out in Canada since 1953. From 1972 on, they were conducted every two years; most of them in selected cities and only some of them including smaller urban and rural areas (1969, 1982, 1986, 1992, 1996 and 2001). The survey is carried out by the Income Statistics Division at Statistics Canada and provides national coverage for the 10 provinces. The main objective of the survey is to provide the basis for monitoring and periodically updating the weights used in the computation of the Consumer Price Index (CPI). As well, the survey provides an excellent data source for a variety of analytical investigations of the food purchasing habits of households in Canada (Income Statistics Division of Statistics Canada, 2003).

The surveys contain quantities and expenditures on a number of food items and, further, on a number of beef, pork, poultry and other meats cuts, as well as processed meats. This study focuses on six aggregate forms of meat: beef high value (hip cuts, loin cuts and rib cuts), beef low value (chuck cuts, stewing beef, ground beef, beef carcasses and primal portions and all other beef), pork high value (leg cuts, loin cuts and belly cuts), pork low value (shoulder cuts,  pork carcasses and primal portions, and all other pork), poultry (chicken (including fowl), turkey and other poultry meat and offal) and other meats (veal, lamb and mutton and offal from other mammals). It is important to note that some of the meat bought by consumers could not end up as consumed meat, a portion of all the meat purchased could become plate waste and some could be used as pet food. Unit value prices are calculated from reported expenditures and quantities, and averages are used as proxy prices for non-consuming households.

The 1996 and 2001 FES contain data on 10,924 and 5,643 households, respectively. For estimation purposes, households that did not consume any meat items during the 2-week period are excluded, leaving 8,066 and 4,269 for the 1996 and 2001 estimations, respectively.

Media indices are used to measure the impact of food safety and health concerns on household demand for meat. The food safety (FSI) and health (HI) indices are built using the publications library of Dow Jones Interactive and the Canadian Newsstand database of ProQuest. The indices are based on the number of newspaper articles published per quarter and per region in the periods 1995-1996 and 2000-2001. The FSI's are counts of the number of articles related to BSE and E. coli for beef, E. coli and

Salmonella for pork, and E. coli and Salmonella for chicken. The HI's are net counts of the number of articles linking consumption of each meat type (beef, pork, and chicken) with cancer, heart disease, and stroke.

Advertising expenditures by the industry are also considered in this analysis. Three kinds of advertising; generic (producer-funded), brand (processor-funded) and restaurant (fast food restaurant chains-funded) are included. Generic advertising is undertaken by producers and they normally fund these expenditures through check-off programs. We obtained these data from the annual reports of the national and the various provincial commodity groups. Brand and restaurant advertising expenditures were obtained from AC Nielsen.

**5.3 Some Descriptives**

The survey is distributed evenly throughout the year. For both years (1996 and 2001), roughly 25 percent of households were surveyed during each quarter. In line with provincial population, Ontario is the region that provides a higher proportion of respondents; around one quarter of all respondents in 1996 and 2001. The Prairies (Manitoba, Saskatchewan and Alberta) contribute 23.3 percent and 21.5 percent in 1996 and 2001, respectively. British Columbia contributed 12.7 percent in 1996 and 15.9 percent in 2001. All regions are represented similarly in both surveys, with the exception of the Atlantic Provinces and Quebec. The percentage of households from the Maritimes decreased substantially from 22.6 percent in 1996 to 12.1 percent in 2001. Meanwhile, the percentage of Quebec respondents went up from 15.7 percent in 1996 to 22.1 percent in 2001.

Most surveyed households are situated in large urban communities (30,000 inhabitants and over) (67.8 percent for 1996 and 71.8 percent for 2001), and are composed by one economic family (96.4 percent for 1996 and 96.5 percent for 2001). Most surveyed household heads are married (63.1 percent for 1996 and 63.7 percent for 2001), are between 25 and 69 years old (81.2 percent for 1996 and 81.7 percent for 2001), live alone, with somebody else or with two other people (72 percent for 1996 and 73.7 percent for 2001). Please refer to Table 5-1.

Table 5-1 Characteristics of the Households Surveyed for the 1996 and 2001 Food Expenditure Surveys

| | 1996 % | 2001 % |
|---|---|---|
| **Season** | | |
| Q1 | 24.6 | 25.9 |
| Q2 | 25.5 | 23.4 |
| Q3 | 25 | 24.3 |
| Q4 | 24.9 | 26.4 |
| **Region** | | |
| Atlantic | 22.6 | 12.1 |
| Quebec | 15.7 | 22.1 |
| Ontario | 25.5 | 28.4 |
| Prairies | 23.3 | 21.5 |
| B.C. | 12.7 | 15.9 |
| **Size of Area of Residence** | | |
| 30,000 or greater | 67.8 | 71.8 |
| Under 30,000 | 10.4 | 12 |
| Rural | 13.9 | 16.2 |
| **Marital Status** | | |
| Married | 63.1 | 63.7 |
| Never married | 14.3 | 14.5 |
| Other | 22.5 | 21.9 |
| **Age** | | |
| 24 and under | 5 | 4.9 |
| 25-69 | 81.2 | 81.7 |
| 70-74 | 5.5 | 4.92 |
| 75-79 | 4 | 4.12 |
| 80 or older | 4.2 | 4.28 |
| **Sex** | | |
| Male | 47.8 | 41.7 |
| Female | 52.2 | 58.3 |

| | 1996 % | 2001 % |
|---|---|---|
| **Household Size** | | |
| 1 | 23 | 23 |
| 2 | 32.2 | 34.4 |
| 3 | 16.8 | 16.3 |
| 4 | 18.1 | 17.4 |
| 5 | 7.1 | 6.3 |
| 6 or more | 2.8 | 2.6 |
| **Seniors (65 or older)** | | |
| 0 | 77.5 | 77.3 |
| 1 | 15 | 14.9 |
| 2 or more | 7.5 | 7.8 |
| **Adults (25 to 64)** | | |
| 0 | 19.4 | 19.2 |
| 1 | 25.9 | 26.1 |
| 2 or more | 54.7 | 54.8 |
| **Youths (15 to 24)** | | |
| 0 | 75.5 | 75.8 |
| 1 | 15.4 | 15.8 |
| 2 or more | 9.1 | 8.4 |
| **Children (under 15)** | | |
| 0 | 67.6 | 69.1 |
| 1 | 14.1 | 14.2 |
| 2 or more | 18.3 | 16.6 |
| **Number of Economic Families** | | |
| 1 | 96.4 | 96.5 |
| 2 or more | 3.6 | 3.5 |

Some sample statistics are shown in Tables 5-2 and 5-3. For 1996, average quantity purchased of beef high value, beef low value, pork high value, pork low value, poultry, and other meats is 0.64, 1.22, 0.53, 0.12, 1.79 and 0.15 kg/2-week period, respectively. For 2001, average consumption of such meats, in the same order, is 0.48, 0.87, 0.47, 0.13, 1.52 and 0.12 kg/2-week period. Averages on consuming household consumption are also presented.

Table 5-2 1996 Food Expenditure Survey, Sample Data Covering Meat Consumption

| **1996 Sample Statistics (sample size = 10,924 households)** | | | |
|---|---|---|---|
| Variables | | Mean | Std. Dev. |
| Quantities (kg/two-week period) | | | |
| Beef High Value | Full Sample | 0.636 | 1.954 |
| | Consuming Households (3557) | 1.953 | 3.025 |
| Beef Low Value | Full Sample | 1.224 | 3.128 |
| | Consuming Households (5568) | 2.402 | 4.046 |
| Pork High Value | Full Sample | 0.528 | 1.355 |
| | Consuming Households (3321) | 1.790 | 1.992 |
| Pork Low Value | Full Sample | 0.124 | 0.690 |
| | Consuming Households (756) | 1.796 | 1.969 |
| Poultry | Full Sample | 1.786 | 3.756 |
| | Consuming Households (5521) | 3.535 | 4.663 |
| Other Meats | Full Sample | 0.147 | 1.074 |
| | Consuming Households (1144) | 1.405 | 3.044 |
| Prices ($/kg) | | | |
| Beef High Value | | 9.123 | 3.825 |
| Beef Low Value | | 5.569 | 2.207 |
| Pork High Value | | 7.513 | 3.105 |
| Pork Low Value | | 4.918 | 2.262 |
| Poultry | | 5.942 | 3.564 |
| Other Meats | | 6.966 | 4.870 |

Table 5-3 2001 Food Expenditure Survey, Sample Data Covering Meat Consumption

| **2001 Sample Statistics (sample size = 5,643 households)** | | | |
|---|---|---|---|
| Variables | | Mean | Std. Dev. |
| Quantities (kg/two-week period) | | | |
| Beef High Value | Full Sample | 0.491 | 1.114 |
| | Consuming Households (1780) | 1.557 | 1.509 |
| Beef Low Value | Full Sample | 0.873 | 2.829 |
| | Consuming Households (2471) | 1.994 | 4.006 |
| Pork High Value | Full Sample | 0.471 | 1.287 |
| | Consuming Households (1668) | 1.592 | 1.955 |
| Pork Low Value | Full Sample | 0.130 | 1.786 |
| | Consuming Households (351) | 2.082 | 6.880 |
| Poultry | Full Sample | 1.520 | 3.043 |
| | Consuming Households (2834) | 3.026 | 3.726 |
| Other Meats | Full Sample | 0.119 | 0.560 |
| | Consuming Households (569) | 1.176 | 1.367 |
| Prices ($/kg) | | | |
| Beef High Value | | 11.919 | 5.837 |
| Beef Low Value | | 6.330 | 2.316 |
| Pork High Value | | 9.005 | 3.499 |
| Pork Low Value | | 5.607 | 2.727 |
| Poultry | | 7.443 | 4.386 |
| Other Meats | | 9.592 | 6.214 |

Table 5-4 shows the expenditure shares for the various meat cuts considered in this study. Beef continues to be important when people allocate their meat budget; representing almost one half of the expenditures in 1996 and 43 percent in 2001. While the overall beef expenditure share has declined, it is interesting to see that this decrease has been driven by the expenditure share of beef low value cuts. The expenditure share of beef high value cuts has slightly increased. The pork expenditure share has increased from 16.4 to 17 percent; this change has been caused by an increase in the expenditures on pork high value cuts. The poultry expenditure share has increased from 32.9 to 35.6

percent. The expenditure shares of pork, poultry and other meats have increase at the cost of beef low value cuts.

Table 5-4 Expenditure shares for the various meat cuts, 1996 and 2001 Food Expenditure Surveys

| | 1996 | | 2001 | |
|---|---|---|---|---|
| **Beef High Value** | 0.182 | | 0.187 | |
| **Beef Low Value** | 0.290 | 0.473 | 0.247 | 0.435 |
| **Pork High Value** | 0.140 | | 0.149 | |
| **Pork Low Value** | 0.024 | 0.164 | 0.021 | 0.170 |
| **Poultry** | 0.329 | | 0.356 | |
| **Other Meats** | 0.035 | | 0.040 | |

### 5.4 Estimation Results

TSP 4.5 is used for the estimation of the two-stage meat demand systems. Estimations are carried out separately for the two years; 1996 and 2001. The equations are estimated simultaneously with substitutions of endogenous variables from one stage into the other stage in both cases.

A number of regressions were run using the same basic models but restricting the coefficients for advertising and the media indices at the first stage of the demand systems. As well, the demographic variables were restricted to zero at the second stage of the demand systems. Likelihood ratio tests ($\lambda_{LR} = 2[\ln(L)_u - \ln(L)_r]$) were conducted to estimate the importance of the inclusion of such variables in the final model. We reject the null hypotheses that the food safety index, the health index, and advertising have no effect on total expenditure on meats in 1996. We reject the null hypotheses that the food safety index and advertising have no effect on total expenditure on meats in 2001. We also reject the null hypotheses that seasonality, region, size of area of residence, marital status, age, sex, household type, presence of different age groups in the household, family size, income level and food away from home expenditures have no effect on the shares of beef high value, beef low value, pork high value, pork low value, poultry and other meats in the second stage. Therefore, advertising, the food safety and health indices, and the demographic variables considered for this study should be retained in the final demand systems. Tables 5-5 and 5-6 presents the LR test statistics ($\lambda_{LR}$).

Table 5-5 Log-likelihood ratio test results for model specification, 1996 Food Expenditure Survey

| Model | Log-likelihood | LR test statistics |
|---|---|---|
| Original | 507.869 | |
| **FIRST ST** | | |
| Food Safety | 502.172 | 11.394 *** |
| Health | 504.350 | 7.038 *** |
| Advertising | 498.170 | 19.398 *** |
| **SECOND ST** | | |
| Seasonality | 480.383 | 54.972 *** |
| Region | 473.832 | 68.074 *** |
| Size of Area of Residence | 483.436 | 48.866 *** |
| Marital Status | 500.750 | 14.238 *** |
| Age | 484.416 | 46.906 *** |
| Sex | 495.547 | 24.644 *** |
| Household Size | 488.610 | 38.518 *** |
| Age groups | 495.181 | 25.376 *** |
| Family Size | 507.356 | 1.026 |
| Income | 459.279 | 97.180 *** |
| FAFH | 503.790 | 8.158 *** |

Note: *** indicate significance at the 1 percent level.
(Chi-square critical values are 6.635 (1%), 3.841 (5%), and 2.706 (10%)

Table 5-6 Log-likelihood ratio test results for model specification, 2001 Food Expenditure Survey

| Model | Log-likelihood | LR test statistics |
|---|---|---|
| Original | 35.964 | |
| **FIRST ST** | | |
| Food Safety | 33.441 | 5.046 ** |
| Health | 35.699 | 0.531 |
| Advertising | 34.365 | 3.198 * |
| **SECOND ST** | | |
| Seasonality | 29.454 | 13.019 *** |
| Region | 2.601 | 66.726 *** |
| Size of area of residence | 23.444 | 25.041 *** |
| Marital Status | 27.734 | 16.460 *** |
| Age | 30.433 | 11.062 *** |
| Sex | 34.018 | 3.891 ** |
| Household Size | 27.694 | 16.540 *** |
| Age groups | 29.976 | 11.976 *** |
| Family Size | 31.315 | 9.298 *** |
| Income | 8.488 | 54.952 *** |
| FAFH | 32.074 | 7.781 *** |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.
(Chi-square critical values are 6.635 (1%), 3.841 (5%), and 2.706 (10%)

The specifications for both years are basically the same, with a subtle difference at the first stage between 1996 and 2001; advertising expenditures are modeled differently. In 1996 the sum of generic and brand advertising for each meat type is included in the model, while for 2001 the sum of all the three kinds of advertising (generic, brand and restaurant) for all meats is used. Table 5-7 presents parameter estimates of the total expenditure function (1$^{st}$ stage) for both estimations.

Table 5-7 Multiple regression estimates of the total expenditure function for meat consumption in Canada, 1996 and 2001 Food Expenditure Surveys.

| Parameter | 1996 | | 2001 | |
|---|---|---|---|---|
| | Estimate | t-statistic | Estimate | t-statistic |
| Intercept | 2.249 *** | 2.935 | 2.306 *** | 6.414 |
| Price | -0.043 * | -1.867 | 0.068 ** | 2.263 |
| Income | 0.364 *** | 27.435 | 0.141 *** | 9.508 |
| Food Safety | -0.223 *** | -3.377 | -0.098 ** | -2.248 |
| Health | 0.008 *** | 2.653 | 0.001 | 0.728 |
| Total Advertising | | | 0.051 ** | 1.789 |
| Advertising (beef) | 0.220 | 0.972 | | |
| Advertising (pork) | -1.080 | -1.404 | | |
| Advertising (chicken) | 0.924 * | 1.713 | | |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively
Although only the parameter estimates for the first stage equation are reported in this table, the system was estimated simultaneously with the second stage equations. Parameter estimates for the second stage equations are reported in Appendix D.

The equation for other meats was left out in order to estimate the meat demand system. Then, the parameters of the other meats equation are obtained back from the rest of the equations. The estimated parameters of the AIDS share equations for both years are presented in Appendix D.

At the first stage, food safety impacts negatively and significantly total expenditure on meats in both estimations; at the 1 percent level for the 1996 estimation and at the 5 percent level in 2001 (Table 5-8). Health is only significant (1%) for the 1996 estimation, having a positive effect on total expenditure. This positive result is expected since a net health index is used for the estimation (Table 5-9). Only the sum of generic, brand and restaurant chicken advertising significantly (10%) increases expenditure on meats in 1996. In 2001, the sum of the three types of advertising for all meats positively affects total expenditure.

Table 5-8 First stage own-food safety elasticities, 1996 and 2001 Food Expenditure Surveys

| | 1996 | 2001 |
|---|---|---|
| BH Q | -0.040 *** | -0.018 ** |
| | [-3.377] | [-2.247] |
| BL Q | -0.068 *** | -0.024 ** |
| | [-3.377] | [-2.247] |
| PH Q | -0.030 *** | -0.015 ** |
| | [-3.377] | [-2.247] |
| PL Q | -0.005 *** | -0.002 ** |
| | [-3.377] | [-2.247] |
| P Q | -0.071 *** | -0.035 ** |
| | [-3.377] | [-2.247] |
| OM Q | -0.009 *** | -0.004 ** |
| | [-3.377] | [-2.247] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats.
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics.

Table 5-9 First stage own-health elasticities, 1996 and 2001 Food Expenditure Surveys

| | 1996 | 2001 |
|---|---|---|
| BH Q | 1.38E-03 *** | 1.68E-04 |
| | [2.653] | [0.728] |
| BL Q | 2.34E-03 *** | 2.22E-04 |
| | [2.653] | [0.728] |
| PH Q | 1.04E-03 *** | 1.33E-04 |
| | [2.653] | [0.728] |
| PL Q | 1.84E-04 *** | 1.89E-05 |
| | [2.653] | [0.728] |
| P Q | 2.45E-03 *** | 3.19E-04 |
| | [2.653] | [0.728] |
| OM Q | 2.96E-04 *** | 3.55E-05 |
| | [2.653] | [0.728] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

Prices are found to be very important in determining consumption of the various meats in Canada. Price elasticity estimates for both years are presented in Tables 5-10 to 5-13. Across the two stages, all own-price elasticities are negative and highly significant for both estimations and most of the cross-price elasticities are positive and significant, suggesting that the goods considered in both demand systems are gross substitutes. The second stage estimates are very much in keeping with the across-two stage elasticities; the magnitudes are very similar and only two more elasticities become significant for 1996, the cross effects of pork high value price and pork low value price on beef low value consumption.

Table 5-10 Across two-stage own- and cross-price elasticities, 1996 Food Expenditure Survey

| | BH Price | BL Price | PH Price | PL Price | P Price | OM Prices |
|---|---|---|---|---|---|---|
| BH Q | **-1.731** *** | 0.127 *** | 0.197 *** | 0.090 *** | 0.171 *** | 0.098 *** |
| | **[-31.189]** | [3.057] | [5.019] | [3.870] | [5.385] | [3.775] |
| BL Q | 0.067 *** | **-1.287** *** | 0.037 | 0.018 | 0.066 *** | 0.021 |
| | [2.602] | **[-37.626]** | [1.543] | [1.300] | [3.115] | [1.331] |
| PH Q | 0.266 *** | 0.106 ** | **-1.669** *** | 0.060 ** | 0.120 *** | 0.082 *** |
| | [5.119] | [2.091] | **[-25.120]** | [1.992] | [3.197] | [2.456] |
| PL Q | 0.735 *** | 0.396 *** | 0.372 ** | **-2.557** *** | -0.147 | 0.195 |
| | [4.250] | [2.628] | [2.191] | **[-10.794]** | [-1.485] | [1.299] |
| P Q | 0.087 *** | 0.062 *** | 0.040 ** | -0.025 *** | **-1.233** *** | -0.014 |
| | [4.457] | [3.027] | [2.251] | [-2.363] | **[-49.624]** | [-1.170] |
| OM Q | 0.490 *** | 0.266 *** | 0.305 *** | 0.120 | 0.000 | **-2.191** *** |
| | [4.107] | [2.440] | [2.629] | [1.288] | [0.004] | **[-17.373]** |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics, bold values are own price elasticities.

Table 5-11 Second stage own- and cross-price elasticities, 1996 Food Expenditure Survey

| | BH Price | BL Price | PH Price | PL Price | P Price | OM Prices |
|---|---|---|---|---|---|---|
| BH Q | **-1.723** *** | 0.135 *** | 0.205 *** | 0.098 *** | 0.179 *** | 0.106 *** |
| | **[-31.070]** | [3.269] | [5.234] | [4.256] | [5.728] | [4.121] |
| BL Q | 0.080 *** | **-1.274** *** | 0.050 ** | 0.031 *** | 0.031 *** | 0.034 ** |
| | [3.269] | **[-38.045]** | [2.214] | [2.636] | [2.636] | [2.456] |
| PH Q | 0.272 *** | 0.112 ** | **-1.663** *** | 0.066 ** | 0.126 *** | 0.087 *** |
| | [5.234] | [2.2140] | **[-25.052]** | [2.197] | [3.369] | [2.644] |
| PL Q | 0.736 *** | 0.397 *** | 0.373 ** | **-2.556** *** | -0.146 | 0.196 |
| | [4.256] | [2.636] | [2.197] | **[-10.790]** | [-1.475] | [1.307] |
| P Q | 0.101 *** | 0.076 *** | 0.054 *** | -0.011 | **-1.220** *** | 0.000 |
| | [5.728] | [3.859] | [3.369] | [-1.475] | **[-51.497]** | [0.026] |
| OM Q | 0.492 *** | 0.267 *** | 0.307 *** | 0.122 | 0.002 | **-2.190** *** |
| | [4.121] | [2.456] | [2.644] | [1.307] | [0.026] | **[-17.362]** |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics, bold values are own price elasticities.

For 2001 the comparison between across-two stage and second stage shows that the results are very similar, too. The magnitudes are very close and the significance of the different estimates is very close between the two sets of elasticities.

Table 5-12 Across two-stage own- and cross-price elasticities, 2001 Food Expenditure Survey

| | BH Price | BL Price | PH Price | PL Price | P Price | OM Prices |
|---|---|---|---|---|---|---|
| BH Q | **-1.431** *** | 0.041 | 0.133 *** | 0.098 *** | 0.143 *** | 0.092 *** |
| | **[-20.3549]** | [0.736866] | [2.60149] | [3.82681] | [3.45561] | [2.70044] |
| BL Q | 0.038 | **-1.336** *** | 0.157 *** | 0.055 *** | 0.139 *** | 0.047 *** |
| | [0.898355] | **[-22.5793]** | [3.77936] | [2.60803] | [4.15154] | [1.69152] |
| PH Q | 0.161 *** | 0.244 *** | **-1.758** *** | 0.116 *** | 0.186 *** | 0.112 *** |
| | [2.51634] | [3.57888] | **[-20.3617]** | [3.32902] | [3.97104] | [2.52051] |
| PL Q | 0.757 *** | 0.452 ** | 0.745 *** | **-3.343** *** | 0.048 | 0.350 |
| | [3.4108] | [1.96157] | [3.06795] | **[-9.61612]** | [0.368287] | [1.56799] |
| P Q | 0.093 *** | 0.109 *** | 0.098 *** | 0.027 ** | **-1.197** *** | 0.015 |
| | [3.77352] | [4.42753] | [4.35941] | [2.01806] | **[-38.9622]** | [0.974654] |
| OM Q | 0.379 *** | 0.189 | 0.387 ** | 0.189 | -0.078 | **-2.050** *** |
| | [2.37132] | [1.14466] | [2.32055] | [1.58407] | [-0.756555] | **[-11.0936]** |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics, bold values are own price elasticities.

Table 5-13 Second stage own- and cross-price elasticities, 2001 Food Expenditure Survey

| | BH Price | BL Price | PH Price | PL Price | P Price | OM Prices |
|---|---|---|---|---|---|---|
| BH Q | **-1.444** *** | 0.028 | 0.120 ** | 0.085 *** | 0.131 *** | 0.080 ** |
| | **[-20.574]** | [0.510] | [2.360] | [3.404] | [3.211] | [2.354] |
| BL Q | 0.021 | **-1.353** *** | 0.140 *** | 0.038 ** | 0.038 ** | 0.030 |
| | [0.510] | **[-23.098]** | [3.442] | [1.955] | [1.955] | [1.129] |
| PH Q | 0.151 ** | 0.234 *** | **-1.768** *** | 0.106 *** | 0.176 *** | 0.102 ** |
| | [2.360] | [3.442] | **[-20.498]** | [3.062] | [3.781] | [2.304] |
| PL Q | 0.756 *** | 0.450 ** | 0.743 *** | **-3.345** *** | 0.047 | 0.349 |
| | [3.404] | [1.955] | [3.062] | **[-9.620]** | **[0.357]** | [1.562] |
| P Q | 0.069 *** | 0.085 *** | 0.073 *** | 0.003 | **-1.221** *** | -0.009 |
| | [3.210] | [3.671] | [3.781] | [0.357] | [-42.258] | [-0.783] |
| OM Q | 0.377 ** | 0.186 | 0.384 ** | 0.186 | -0.080 | **-2.053** *** |
| | [2.354] | [1.129] | [2.304] | [1.562] | [-0.783] | **[-11.109]** |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics, bold values are own price elasticities.

Age, household size and food away from home elasticities are presented in Tables 5-14, 5-15 and 5-16, respectively. For 1996, age significantly decreases consumption of beef low value and poultry, while increases pork high value, pork low value and other meats. For 2001, age only has a significant impact on poultry (negative) and other meats (positive) consumption. Contrary to expected, poultry consumption decreases as age of people increases in both 1996 and 2001. A possible explanation for this is that non-traditional dishes using chicken or turkey require additional knowledge of cooking recipes that might be better acquired by younger people, while older people may continue traditional ways of cooking. Consistently for both years, household size significantly increases consumption of low value beef and decreases consumption of beef high value. This result makes sense; bigger households might be more income-restricted than households with fewer people, while households with fewer people can sacrifice quantity in order to get high value cuts. In 2001, household size has a significant impact on consumption of pork low value. Again, indicating that households with more people might decrease consumption of high value pork cuts as they have to feed more people. Food Away From Home (FAFH) only has an impact in 1996, increasing consumption of beef high value and decreasing consumption of beef low value. People consuming FAFH more frequently may enjoy a higher income and, thus, have a tendency to buy high value cuts when eating at home.

Table 5-14 Second stage age elasticities, 1996 and 2001 Food Expenditure Survey

| | 1996 | 2001 |
|---|---|---|
| BH Q | -2.40E-04 | 3.30E-04 |
| | [-0.135] | [0.136] |
| BL Q | -2.38E-03 ** | 1.29E-03 |
| | [-1.880] | [0.629] |
| PH Q | 4.68E-03 ** | 2.99E-03 |
| | [2.181] | [1.085] |
| PL Q | 1.37E-02 *** | 9.15E-03 |
| | [2.579] | [1.258] |
| P Q | -3.39E-03 *** | -4.22E-03 *** |
| | [-2.654] | [-2.600] |
| OM Q | 2.78E-03 *** | 1.36E-03 ** |
| | [5.592] | [2.084] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics.

Table 5-15 Second stage household size elasticities, 1996 and 2001 Food Expenditure Surveys

| | 1996 | 2001 |
|---|---|---|
| BH Q | -1.33E-01 *** | -0.082 ** |
| | [-5.397] | [-2.349] |
| BL Q | 6.94E-02 *** | 0.090 *** |
| | [4.069] | [3.099] |
| PH Q | -3.52E-02 | -0.075 ** |
| | [-1.215] | [-1.922] |
| PL Q | 0.053947 | 0.012 |
| | [0.752] | [0.113] |
| P Q | 2.20E-02 | 0.022 |
| | [1.270] | [0.941] |
| OM Q | -8.03E-04 | -0.004 |
| | [-0.374] | [-1.088] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics.

Table 5-16 Second stage FAFH elasticities, 1996 and 2001 Food Expenditure Survey

| | 1996 | 2001 |
|---|---|---|
| BH Q | 3.87E-04 ** | 3.07E-04 |
| | [1.867] | [1.336] |
| BL Q | -3.10E-04 ** | -2.76E-04 |
| | [-2.160] | [-1.454] |
| PH Q | 3.50E-04 | -1.79E-04 |
| | [1.438] | [-0.702] |
| PL Q | -4.08E-05 | -1.03E-03 |
| | [-0.067] | [-1.528] |
| P Q | -6.07E-05 | 8.25E-05 |
| | [-0.417] | [0.547] |
| OM Q | -5.38E-05 | 7.51E-04 |
| | [-0.115] | [1.386] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
** indicate significance at the 5 percent level.
Values in square brackets are t-statistics.

## 5.5 Demographic Elasticities

One of the advantages of using microdata is that it is possible to look at the impact of certain demographic factors such as region of residence, education or income. Regional elasticities for 1996 and 2001 are calculated to look at the difference in response to price, food safety issues and health concerns according to the area of residence (Tables 5-17 to 5-22). All elasticity estimates are based on common parameters rather than regional estimates. Therefore, the base estimation is used to calculate the elasticities by getting sub-samples with the desired demographic characteristics.

For 1996, the Atlantic Provinces are the most responsive to the price of beef high value. There is only minor variation of the elasticites for beef low value and pork high value across provinces. Consumption of poultry and other meats are the least and the most price responsive for all provinces, respectively; the lowest poultry price elasticity is -1.213 (BC) and the highest is -1.251 (Quebec). On the other hand, other meats-price elasticities vary from -1.738 (Quebec) to -3.474 (Atlantic). This might be due to the fact that diets are different depending on the region; in some places it could be more common to eat lamb more frequently whereas in others it is a treat that can only be afforded when there is a sale at the grocery store.

Table 5-17 Regional own-price elasticities, 1996 Food Expenditure Survey

| | Atlantic | Quebec | Ontario | Prairies | BC |
|---|---|---|---|---|---|
| BH | -1.792 *** | -1.627 *** | -1.744 *** | -1.744 *** | -1.657 *** |
| | [-29.766] | [-34.239] | [-30.846] | [-30.848] | [-33.273] |
| BL | -1.273 *** | -1.289 *** | -1.315 *** | -1.292 *** | -1.370 *** |
| | [-39.137] | [-37.450] | [-34.994] | [-37.157] | [-30.945] |
| PH | -1.619 *** | -1.815 *** | -1.644 *** | -1.600 *** | -1.621 *** |
| | [-26.375] | [-22.370] | [-25.708] | [-26.895] | [-26.302] |
| PL | -2.680 *** | -2.736 *** | -2.591 *** | -2.409 *** | -2.425 *** |
| | [-10.485] | [-10.358] | [-10.703] | [-11.240] | [-11.187] |
| P | -1.229 *** | -1.251 *** | -1.216 *** | -1.230 *** | -1.213 *** |
| | [-50.352] | [-46.956] | [-52.475] | [-50.144] | [-53.042] |
| OM | -3.474 *** | -1.738 *** | -2.248 *** | -2.939 *** | -2.110 *** |
| | [-13.249] | [-22.288] | [-17.011] | [-14.305] | [-17.959] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

For 2001, the own-price elasticities for beef high value are smaller than those for 1996. Again, the most price elastic for beef high value are the Atlantic Provinces. Poultry elasticities are the least varying of the own-price elasticities across provinces, followed by the beef low value elasticities. The reason for this might be that beef low value cuts and poultry are the two most important meats of the consumer meat bundle in Canada (3.026 kg/two-week period of poultry and 1.994 kg/two-week period of beef low value cuts in 2001). Buying these meats might be part of the normal grocery trip and does not depend that much on getting them on sale, thus the demand for them is more constant than for other cuts.

Table 5-18 Regional own-price elasticities, 2001 Food Expenditure Survey

| | Atlantic | Quebec | Ontario | Prairies | BC |
|---|---|---|---|---|---|
| BH | -1.539 *** | -1.360 *** | -1.423 *** | -1.436 *** | -1.507 *** |
| | [-17.703] | [-22.840] | [-20.605] | [-20.218] | [-18.382] |
| BL | -1.295 *** | -1.307 *** | -1.375 *** | -1.311 *** | -1.394 *** |
| | [-24.481] | [-23.886] | [-21.071] | [-23.662] | [-20.433] |
| PH | -1.637 *** | -1.976 *** | -1.746 *** | -1.729 *** | -1.685 *** |
| | [-22.424] | [-17.877] | [-20.532] | [-20.795] | [-21.529] |
| PL | -3.193 *** | -3.151 *** | -3.782 *** | -3.956 *** | -2.705 *** |
| | [-9.812] | [-9.872] | [-9.1642] | [-9.022] | [-10.687] |
| P | -1.196 *** | -1.244 *** | -1.181 *** | -1.195 *** | -1.175 *** |
| | [-39.038] | [-34.947] | [-40.396] | [-39.185] | [-40.882] |
| OM | -3.828 *** | -1.567 *** | -2.155 *** | -3.188 *** | -1.979 *** |
| | [-7.709] | [-15.611] | [-10.607] | [-8.296] | [-11.484] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

Quebec is the region that has responded the most to food safety issues when it comes to the consumption of beef high value cuts for both estimations 1996 and 2001, followed by BC in 1996 and Ontario in 2001. In general, for all regions and for all meats, the 1996 food safety elasticities are bigger than those from 2001. With the announcement of the possible link between BSE and new variant Creutzfeldt Jakob disease (nCJD) in 1996, the amount of food safety information was almost overwhelming, which may be a reason for having a greater response in 1996. The impact of meat safety issues is bigger in beef low value cuts than in high value cuts; which makes sense since beef low value cuts (specifically hamburger) are the cuts normally associated to meat safety issues. Pork low value cuts and other meats are the least affected by meat safety issues. In the case of other meats, the impact is smaller because the meat safety index only takes into account beef, pork and chicken safety issues. It is interesting to find that poultry consumption is the most responsive to meat safety issues in both years. E. coli and Salmonella might have been perceived by Canadians as more important issues than BSE, at least in 1996 and 2001, when BSE might have been thought of as an external issue that had no effect on the supply of meat in Canada.

Table 5-19 Regional food safety elasticities, 1996 Food Expenditure Survey

| | Atlantic | Quebec | Ontario | Prairies | BC |
|---|---|---|---|---|---|
| BH | -0.037 *** | -0.047 *** | -0.039 *** | -0.039 *** | -0.045 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| BL | -0.072 *** | -0.067 *** | -0.061 *** | -0.067 *** | -0.052 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| PH | -0.033 *** | -0.025 *** | -0.031 *** | -0.034 *** | -0.033 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| PL | -0.005 *** | -0.005 *** | -0.005 *** | -0.006 *** | -0.006 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| P | -0.073 *** | -0.065 *** | -0.078 *** | -0.072 *** | -0.079 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| OM | -0.004 *** | -0.014 *** | -0.008 *** | -0.005 *** | -0.009 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

Table 5-20 Regional food safety elasticities, 2001 Food Expenditure Survey

| | Atlantic | Quebec | Ontario | Prairies | BC |
|---|---|---|---|---|---|
| BH | -0.015 ** | -0.022 ** | -0.019 ** | -0.018 ** | -0.016 ** |
| | [-2.248] | [-2.248] | [-2.248] | [-2.248] | [-2.248] |
| BL | -0.027 ** | -0.026 ** | -0.022 ** | -0.026 ** | -0.021 ** |
| | [-2.248] | [-2.248] | [-2.248] | [-2.248] | [-2.248] |
| PH | -0.017 ** | -0.011 ** | -0.015 ** | -0.015 ** | -0.016 ** |
| | [-2.248] | [-2.248] | [-2.248] | [-2.248] | [-2.248] |
| PL | -0.002 ** | -0.002 ** | -0.002 ** | -0.002 ** | -0.003 ** |
| | [-2.248] | [-2.248] | [-2.248] | [-2.248] | [-2.248] |
| P | -0.035 ** | -0.029 ** | -0.037 ** | -0.035 ** | -0.038 ** |
| | [-2.248] | [-2.248] | [-2.248] | [-2.248] | [-2.248] |
| OM | -0.001 ** | -0.007 ** | -0.004 ** | -0.002 ** | -0.004 ** |
| | [-2.248] | [-2.248] | [-2.248] | [-2.248] | [-2.248] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
** indicate significance at the 5 percent level.
Values in square brackets are t-statistics.

Health concerns have had a smaller impact on meat consumption than food safety issues, at least when considering household demand for meats. It has been found before that negative information has impacted consumption of some foods more importantly than positive information, which is also the case of the cross sectional estimation of this study. Moreover, only the health elasticities for 1996 are significantly different from zero. For 1996, poultry consumption responds the most to information about meat and health. White meats have been normally perceived as 'healthier' for one's health and the information found in newspapers is most of the times in accord to this belief.

Table 5-21 Regional health elasticities, 1996 Food Expenditure Survey

| | Atlantic | Quebec | Ontario | Prairies | BC |
|---|---|---|---|---|---|
| **BH** | 0.00127 *** | 0.00161 *** | 0.00135 *** | 0.00135 *** | 0.00154 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| **BL** | 0.00247 *** | 0.00232 *** | 0.00211 *** | 0.00230 *** | 0.00178 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| **PH** | 0.00113 *** | 0.00085 *** | 0.00108 *** | 0.00116 *** | 0.00112 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| **PL** | 0.00017 *** | 0.00017 *** | 0.00018 *** | 0.00020 *** | 0.00020 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| **P** | 0.00251 *** | 0.00226 *** | 0.00268 *** | 0.00249 *** | 0.00273 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| **OM** | 0.00014 *** | 0.00048 *** | 0.00028 *** | 0.00018 *** | 0.00032 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

Table 5-22 Regional health elasticities, 2001 Food Expenditure Survey

| | Atlantic | Quebec | Ontario | Prairies | BC |
|---|---|---|---|---|---|
| BH | 0.00014 | 0.00020 | 0.00017 | 0.00017 | 0.00014 |
| | [0.728] | [0.728] | [0.728] | [0.728] | [0.728] |
| BL | 0.00025 | 0.00024 | 0.00020 | 0.00024 | 0.00019 |
| | [0.728] | [0.728] | [0.728] | [0.728] | [0.728] |
| PH | 0.00016 | 0.00010 | 0.00014 | 0.00014 | 0.00015 |
| | [0.728] | [0.728] | [0.728] | [0.728] | [0.728] |
| PL | 0.00002 | 0.00002 | 0.00002 | 0.00002 | 0.00003 |
| | [0.728] | [0.728] | [0.728] | [0.728] | [0.728] |
| P | 0.00032 | 0.00027 | 0.00034 | 0.00032 | 0.00035 |
| | [0.728] | [0.728] | [0.728] | [0.728] | [0.728] |
| OM | 0.00001 | 0.00007 | 0.00003 | 0.00002 | 0.00004 |
| | [0.728] | [0.728] | [0.728] | [0.728] | [0.728] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
Values in square brackets are t-statistics.

Education and income are demographic characteristics that may influence the demand for foods. The microdata available from 1996 provide information on the educational level of the reference person (the person who filled the food consumption diary), and provides 5 different levels of education. Level 1 is less than 9 years of education, level 2 means some or completed secondary education, level 3 is some post-secondary education, level 4 represents post-secondary non-university certificate or diploma, and level 5 is for people who hold a university degree. Unfortunately the same information is not available for 2001. Nevertheless, even when it may not always be the case, a higher level of education may be associated with a higher level of income. Therefore, for 2001 an income classification is used instead of the level of education. Income 1 refers to low income households (equal to or less than $29,999), income 2 is for middle income households (from $30,000 to $59,999) and income 3 refers to high income households ($60,000 or more).

It is found that higher levels of education are associated with less price elastic demands for beef high value cuts and poultry, while the contrary is the case for beef low value cuts and pork low value cuts. These results may arise from the fact stated in the previous paragraph: higher education may mean higher income. Thus, university educated people are less responsive to changes in the price of high value cuts as compared to people with less than nine years of education. Own-price elasticities for pork high value cuts are relatively around the same level across educational levels. Interestingly, people with less than nine years of education are the least price sensitive with respect to consumption of other meats. Apart from level of education 1, an increased educational level decreases the sensitivity to price for other meats. Please refer to Table 5-23.

Table 5-23 Educational own-price elasticities, 1996 Food Expenditure Survey

| | Edu 1 | Edu 2 | Edu 3 | Edu 4 | Edu 5 |
|---|---|---|---|---|---|
| BH | -1.786 *** | -1.713 *** | -1.702 *** | -1.750 *** | -1.662 *** |
| | [-29.897] | [-31.643] | [-31.953] | [-30.711] | [-33.097] |
| BL | -1.287 *** | -1.284 *** | -1.308 *** | -1.308 *** | -1.350 *** |
| | [-37.6287] | [-37.990] | [-35.617] | [-35.660] | [-32.281] |
| PH | -1.622 *** | -1.618 *** | -1.669 *** | -1.654 *** | -1.740 *** |
| | [-26.290] | [-26.407] | [-25.112] | [-25.474] | [-23.645] |
| PL | -1.986 *** | -2.562 *** | -2.786 *** | -2.781 *** | -3.071 *** |
| | [-13.251] | [-10.780] | [-10.252] | [-10.261] | [-9.744] |
| P | -1.246 *** | -1.241 *** | -1.219 *** | -1.216 *** | -1.204 *** |
| | [-47.719] | [-48.476] | [-51.990] | [-52.502] | [-54.620] |
| OM | -2.017 *** | -2.552 *** | -2.427 *** | -2.307 *** | -2.090 *** |
| | [-18.745] | [-15.523] | [-16.057] | [-16.670] | [-18.111] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

Table 5-24 shows the own-price elasticities associated to the level of income. As with the case of higher educational levels in 1996, as income increases the elasticities for beef high value cuts and poultry decrease. Again, beef low value cuts and pork low value cuts are associated to more elastic demands for higher levels of income. Pork high value cuts elasticities display a relatively stable level across income categories. The own-price elasticity for other meats is smaller for high income households than for low or middle income households. Nevertheless, low income households are less price elastic with respect to consumption of other meats than middle income households, a very similar result to what is found with the level of education.

Table 5-24 Income own-price elasticities, 2001 Food Expenditure Survey

| | Inc 1 | inc 2 | Inc 3 |
|---|---|---|---|
| BH | -1.476 *** | -1.429 *** | -1.396 *** |
| | [-19.120] | [-20.412] | [-21.487] |
| BL | -1.296 *** | -1.317 *** | -1.389 *** |
| | [-24.388] | [-23.399] | [-20.569] |
| PH | -1.732 *** | -1.787 *** | -1.782 *** |
| | [-20.741] | [-19.952] | [-20.022] |
| PL | -2.562 *** | -3.842 *** | -4.150 *** |
| | [-11.047] | [-9.113] | [-8.881] |
| P | -1.219 *** | -1.195 *** | -1.185 *** |
| | [-37.097] | [-39.131] | [-40.053] |
| OM | -2.035 *** | -2.301 *** | -1.888 *** |
| | [-11.171] | [-10.060] | [-12.071] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

Food safety issues are more important for both household heads with higher educational levels (1996) and households with higher income (2001) when it comes to beef high value cuts and poultry consumption. Although, consumption of beef low value cuts is more sensitive to meat safety issues than consumption of beef high value cuts for higher educational levels (i.e. food safety elasticity for beef high value cuts is -0.044, and for beef low value cuts is -0.055 for household heads with university degrees), household heads with less than 9 years of formal education are more sensitive to food safety issues than household heads with university degrees with respect to consumption of beef low value cuts. Consumption of pork low value cuts and other meats are the least affected by meat safety issues across educational and income levels. Please refer to Tables 5-25 and 5-26.

Health elasticities are only significantly different from zero across educational levels (1996), and not across income levels (2001). Newspaper articles about health concerns and meat have had the largest impact on poultry consumption and on highly educated household heads. Health concerns could be expected to have a larger impact on more educated people, since these people might be believed to be more health conscious. Tables 5-27 and 5-28 show the elasticity estimates for health across educational (1996) and income (2001) levels.

Table 5-25 Educational food safety elasticities, 1996 Food Expenditure Survey

| | Edu 1 | Edu 2 | Edu 3 | Edu 4 | Edu 5 |
|---|---|---|---|---|---|
| BH | -0.037 *** | -0.041 *** | -0.042 *** | -0.039 *** | -0.044 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| BL | -0.068 *** | -0.069 *** | -0.063 *** | -0.063 *** | -0.055 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| PH | -0.032 *** | -0.033 *** | -0.030 *** | -0.031 *** | -0.027 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| PL | -0.008 *** | -0.005 *** | -0.005 *** | -0.005 *** | -0.004 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| P | -0.067 *** | -0.069 *** | -0.077 *** | -0.078 *** | -0.083 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |
| OM | -0.010 *** | -0.007 *** | -0.007 *** | -0.008 *** | -0.009 *** |
| | [-3.377] | [-3.377] | [-3.377] | [-3.377] | [-3.377] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

Table 5-26 Income food safety elasticities, 2001 Food Expenditure Survey

| | Inc 1 | Inc 2 | Inc 3 |
|---|---|---|---|
| BH | -0.017 ** | -0.018 ** | -0.020 ** |
| | [-2.248] | [-2.248] | [-2.248] |
| BL | -0.027 ** | -0.026 ** | -0.021 ** |
| | [-2.248] | [-2.248] | [-2.248] |
| PH | -0.015 ** | -0.014 ** | -0.014 ** |
| | [-2.248] | [-2.248] | [-2.248] |
| PL | -0.003 ** | -0.002 ** | -0.002 ** |
| | [-2.248] | [-2.248] | [-2.248] |
| P | -0.032 ** | -0.035 ** | -0.037 ** |
| | [-2.248] | [-2.248] | [-2.248] |
| OM | -0.004 ** | -0.003 ** | -0.005 ** |
| | [-2.248] | [-2.248] | [-2.248] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
** indicate significance at the 5 percent level.
Values in square brackets are t-statistics.

Table 5-27 Educational health elasticities, 1996 Food Expenditure Survey

| | Edu 1 | Edu 2 | Edu 3 | Edu 4 | Edu 5 |
|---|---|---|---|---|---|
| BH | 0.00128 *** | 0.00142 *** | 0.00144 *** | 0.00134 *** | 0.00153 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| BL | 0.00234 *** | 0.00237 *** | 0.00217 *** | 0.00217 *** | 0.00189 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| PH | 0.00112 *** | 0.00113 *** | 0.00104 *** | 0.00106 *** | 0.00094 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| PL | 0.00029 *** | 0.00018 *** | 0.00016 *** | 0.00016 *** | 0.00014 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| P | 0.00231 *** | 0.00237 *** | 0.00264 *** | 0.00268 *** | 0.00287 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |
| OM | 0.00035 *** | 0.00023 *** | 0.00025 *** | 0.00027 *** | 0.00032 *** |
| | [2.653] | [2.653] | [2.653] | [2.653] | [2.653] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics.

Table 5-28 Income health elasticities, 2001 Food Expenditure Survey

| | Inc 1 | Inc 2 | Inc 3 |
|---|---|---|---|
| BH | 0.00015 | 0.00017 | 0.00018 |
| | [0.728] | [0.728] | [0.728] |
| BL | 0.00025 | 0.00023 | 0.00019 |
| | [0.728] | [0.728] | [0.728] |
| PH | 0.00014 | 0.00013 | 0.00013 |
| | [0.728] | [0.728] | [0.728] |
| PL | 0.00003 | 0.00002 | 0.00001 |
| | [0.728] | [0.728] | [0.728] |
| P | 0.00029 | 0.00032 | 0.00034 |
| | [0.728] | [0.728] | [0.728] |
| OM | 0.00004 | 0.00003 | 0.00004 |
| | [0.728] | [0.728] | [0.728] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
Values in square brackets are t-statistics.

## 5.6 Other Impacts of Demographics

The inclusion of dummy variables to take into account the impact of the season, region, size of area of residence, marital status of household head, gender of household head and the presence of a specific age group in the household resulted in finding some specific significant (at least at the 10% level) impacts for some meats. For 1996, households from big urban areas (>30,000) consumed more high value beef than rural lhouseholds, women household heads consumed less beef high value than men household heads. More beef low value was consumed in the third quarter of 1996 as compared to the period from October to December, households with single people consumed less beef low value than households with separated, divorced or widowed people, households with one or more adults (aged 25 to 64) consumed less beef low value than households with no people .in their age group, households with one or more youth (aged 15 to 24) consumed more beef low value than households with no youth. Pork high value was consumed more in the first and third quarters of the year than in the fourth, households from Ontario consumed more pork high value than households from British Columbia, households from big cities (>30,000) consumed less pork high value than rural households and households composed of married people consumed more pork high value than households composed of separated, divorced or widowed people. With respect to pork low value, households from both big and small urban areas consumed less than rural households. Poultry was consumed less in the second and third quarters of the year than in the fourth, households from Quebec consumed less poultry than households from British Columbia, and women household heads consumed more poultry than men household heads.

For 2001, medium (from $30,000 to $59,999) and high ($60,000 or more) income households consumed more beef high value than low income (less than $29,999) households. More beef low value was consumed in Atlantic Canada and in Quebec than in British Columbia, households from big urban areas (>30,000) consumed less beef low value than households from rural areas, households with one or more elderly people (65 or more) consumed less beef low value than households with no elderly people, medium and high income households consumed less beef low value than low income households. Pork high value was consumed less in Quebec than in B.C., households from small urban areas (<30,000) consumed more pork high value than rural households, households composed of married people consumed more pork high value than households characterized by separated, divorced or widowed people. Households from Atlantic Canada consumed less pork low value than households from B.C., households from big urban areas consumed less pork low value than households from rural areas, medium and high income households consumed less pork low value than low income households. Poultry was consumed in lower quantities by households from small urban areas than from rural households, households composed of married people consumed less poultry than households composed of separated, divorced or widowed people, women consumed more poultry than men, and medium and high income households consumed more poultry than low income households.

**5.7 Summary**

This chapter presents the results from the empirical estimation carried out using the 1996 and 2001 Food Expenditure Surveys. From the results obtained it is clear that Canadian meat consumption at the household level is affected differently by demographic characteristics. Price is the most important factor determining consumption but also food safety issues and health concerns have an impact on household meat purchasing decisions. The present chapter takes care of the second objective of this thesis: to determine the impact of meat prices and expenditures on demand for meat regionally and by age, education, family structure and income categories across Canada, as well as to quantify the impact of food safety issues and health concerns on demand for meat across Canada, identifying differences in response by region, education and income.

Tables 5-29 and 5-30 offer a summary of the results for the two estimations carried out using microdata. Own-price elasticities are highly significant and most estimates are around the same magnitude for both years but for beef high value (becoming less price elastic from -1.731 in 1996 to -1.431 in 2001) and pork low value (becoming more price elastic from -2.557 in 1996 to -3.343 in 2001). Food safety issues have negatively and significantly (1% for 1996 and 5% for 2001) impacted meat consumption in both years, but the estimates are bigger for 1996. This might be a result of the media coverage received by the European BSE crisis. Net positive health information is found to impact meat consumption significantly for 1996 only. The expectation was that health would be more important in consumer decision making in 2001 than in 1996, expectation in line with people's increasing awareness about the link between food and health. This may be a result of the smaller sample size for 2001, but it could also be the case that as more confusing information is made available to the public, the impact of such information diminishes. Household head age is significant for all meat cuts but one (beef high value) in 1996, and is only significant for poultry and other meats in 2001. The statistically significant effects across both estimations display the same sign. Household size significantly impacts beef high value (1996 and 2001), beef low value (1996 and 2001) and pork high value (2001), again there is consistency in the direction of the impacts for the statistically significant effects across estimations. Finally, food away from home has significant effects only in 1996; positively impacting consumption of high value beef cuts and having the contrary effect on beef low value cuts.

Table 5-29 Summary of elasticities, 1996 Food Expenditure Survey

| | Price | Food Safety | Health | Age | H. Size | FAFH |
|---|---|---|---|---|---|---|
| BH Q | -1.731 *** | -0.040 *** | 1.38E-03 *** | -2.40E-04 | -1.33E-01 *** | 3.87E-04 ** |
| | [-31.189] | [-3.377] | [2.653] | [-0.135] | [-5.397] | [1.867] |
| BL Q | -1.287 *** | -0.068 *** | 2.34E-03 *** | -2.38E-03 ** | 6.94E-02 *** | -3.10E-04 ** |
| | [-37.626] | [-3.377] | [2.653] | [-1.880] | [4.069] | [-2.160] |
| PH Q | -1.669 *** | -0.030 *** | 1.04E-03 *** | 4.68E-03 ** | -3.52E-02 | 3.50E-04 |
| | [-25.120] | [-3.377] | [2.653] | [2.181] | [-1.215] | [1.438] |
| PL Q | -2.557 *** | -0.005 *** | 1.84E-04 *** | 1.37E-02 *** | 0.053947 | -4.08E-05 |
| | [-10.794] | [-3.377] | [2.653] | [2.579] | [0.752] | [-0.067] |
| P Q | -1.233 *** | -0.071 *** | 2.45E-03 *** | -3.39E-03 *** | 2.20E-02 | -6.07E-05 |
| | [-49.624] | [-3.377] | [2.653] | [-2.654] | [1.270] | [-0.417] |
| OM Q | -2.191 *** | -0.009 *** | 2.96E-04 *** | 2.78E-03 *** | -8.03E-04 | -5.38E-05 |
| | [-17.373] | [-3.377] | [2.653] | [5.592] | [-0.374] | [-0.115] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats

*** and ** indicate significance at the 1 and 5 percent level, respectively.

Values in square brackets are t-statistics.

Table 5-30 Summary of elasticities, 2001 Food Expenditure Survey

| | Price | Food Safety | Health | Age | H. Size | FAFH |
|---|---|---|---|---|---|---|
| BH Q | -1.431 *** | -0.018 ** | 1.68E-04 | 3.30E-04 | -0.082 ** | 3.07E-04 |
| | [-20.3549] | [-2.247] | [0.728] | [0.136] | [-2.349] | [1.336] |
| BL Q | -1.336 *** | -0.024 ** | 2.22E-04 | 1.29E-03 | 0.090 *** | -2.76E-04 |
| | [-22.5793] | [-2.247] | [0.728] | [0.629] | [3.099] | [-1.454] |
| PH Q | -1.758 *** | -0.015 ** | 1.33E-04 | 2.99E-03 | -0.075 ** | -1.79E-04 |
| | [-20.3617] | [-2.247] | [0.728] | [1.085] | [-1.922] | [-0.702] |
| PL Q | -3.343 *** | -0.002 ** | 1.89E-05 | 9.15E-03 | 0.012 | -1.03E-03 |
| | [-9.61612] | [-2.247] | [0.728] | [1.258] | [0.113] | [-1.528] |
| P Q | -1.197 *** | -0.035 ** | 3.19E-04 | -4.22E-03 *** | 0.022 | 8.25E-05 |
| | [-38.9622] | [-2.247] | [0.728] | [-2.600] | [0.941] | [0.547] |
| OM Q | -2.050 *** | -0.004 ** | 3.55E-05 | 1.36E-03 ** | -0.004 | 7.51E-04 |
| | [-11.0936] | [-2.247] | [0.728] | [2.084] | [-1.088] | [1.386] |

Note: BH, BL, PH, PL, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats

*** and ** indicate significance at the 1 and 5 percent level, respectively.

Values in square brackets are t-statistics.

# Chapter 6

# Conclusions

## 6.1 Introduction

In this chapter a comparison of the estimation results obtained in this study is provided. Then some of the implications and contributions of this work are indicated. As well, the possibilities for further research on the issues affecting the demand for meat in Canada are outlined. The emphasis is on drawing conclusions about the robustness of the estimation results obtained, so that the results can be taken into account when making marketing and policy decisions.

## 6.2 Summary of the Study

The aim of this thesis was to determine the factors that shape the demand for meat in Canada. The marketing efforts of the various industry levels; producers (generic advertising), processors (brand advertising) and fast food restaurant chains (restaurant advertising) are incorporated into the analysis. In this study, people's awareness of food safety issues and health concerns are also considered through the use of media indices. In order to determine the robustness of the estimation results, two different data sources are used in this thesis. The first is a time series database covering aggregate meat (beef, pork and chicken) disappearance in Canada from 1978 to 2001. The second database covers meat consumption (beef high value, beef low value, pork high value, pork low value, poultry and other meats) of a cross section of Canadian households in two years; 1996 and 2001.

It is hypothesized that the various kinds of advertising (generic, brand and restaurant) would have positive own effects and negative cross effects. The Food Safety Indices (FSI), based on quarterly counts of newspaper articles published in Canada from 1978 to 2001, and taking into account BSE and E. coli for beef, E. coli and Salmonella for pork, and E. coli and Salmonella for chicken, were expected to have negative own effects and positive cross effects. The Health Indices (HI) are quarterly net counts (positive – negative) of newspaper articles published in Canada from 1978 to 2001 talking about the three meats considered in this study (beef, pork and chicken) and heart disease, cancer and stroke. Since the HI were net counts, they were expected to impact own consumption positively and have negative cross effects. From basic microeconomic theory, it was expected that sales would react negatively to increases in own prices (normal goods), and react positively to changes in cross prices (assuming that the various meats considered are substitutes).

Information variables (advertising and media indices) have been incorporated before in demand analysis. Even though in theory perfect information is assumed, it has been argued that a continuous flow of information might have an effect on consumer decision making, leaving room for informational factors to have an impact on demand. The novelty of this thesis lies in the inclusion of a number of informational factors that have not been considered simultaneously in any previous study. Considering all these media influences together with prices and income could provide better estimates of the elasticities of demand.

The functional forms chosen for this study were the Generalized Box Cox (GBC) and the Almost Ideal Demand System (AIDS). The GBC functional form provides one of the most flexible functional forms. This is especially important in obtaining more accurate cross effects and in capturing flexible responses to changes in expenditure and prices. The GBC functional form is used to model the time series data. Using flexible forms is also advantageous when using cross sectional data, since household budget data offer great scope for estimating expenditure effects and should be analyzed using functional forms capable of reflecting those effects. The AIDS model provides a simple flexible form that does not complicate estimation, which is an issue when using microdata sources. The AIDS model is used for the household data.

Assuming that consumers allocate expenditures in a two-stage budgeting process, models considering total expenditure on meats at the first stage and allocation among individual meats at the second stage were used for both data sets. It was thought that the information variables could affect not only the shares of each meat but also the overall expenditure on meats.

It was found that advertising, food safety issues, health concerns and social marketing (in the form of Canada's Food Guide recommendations) have had an effect on total expenditure on meat in Canada. With respect to the elasticities, which can give a better idea of the factors impacting aggregate meat demand in Canada, it was found that income impacts meat consumption positively, own prices have a negative effect on each meat type and that cross price effects are positive. The information elasticities show that some variables have significant effects on consumption; generic advertising impacts own beef and own pork consumption, brand advertising affects own beef and own chicken consumption, restaurant advertising is significant for own beef consumption, food safety has no own effects for any meat, and health has an effect on own beef and own pork consumption. All the significant own effects display the hypothesized signs. There are some cross effects of the information variables displaying counter intuitive signs; some cross-advertising elasticities being positive, cross-food safety elasticities decreasing consumption of the other meats and net health elasticities increasing consumption of the other meats. Although advertising is only intended to have an own positive effect, it is possible that increased beef advertising would have a negative effect on pork and chicken for example. The fact that these informational factors have unexpected cross effects makes one think that they not only cause an adjustment in allocation among the goods but an increase or decrease in the size of the market as a whole.

Considering household consumption of meat in Canada, it was found that food safety issues, health concerns and advertising expenditures have had an impact on total household expenditures on meats. All own-price elasticities display the expected negative sign and most cross-price elasticities (all but three in 1996 and all but one in 2001) display the hypothesized positive signs, indicating some degree of substitutability among the different meats considered for the cross sectional estimation of this study. Food safety issues negatively impacted meat consumption in both years; 1996 and 2001, while the net health index is only significant (and positive) for 1996. Demographic factors have had an impact on the demand for the different meats in Canada; age, for instance, significantly decreases consumption of low value beef cuts and poultry, while it significantly increases consumption of pork high value and low value cuts, and other meats in 1996. In 2001, age only decreases poultry consumption and drives up other meats sales. Household size consistently decreases beef high value cuts consumption and increases beef low value cuts consumption in both years, while it has a negative impact on pork high value cuts consumption in 2001. Food Away From Home (FAFH) expenditures have significant impacts on both beef high value (positive) and beef low value (negative) cuts only in 1996. It was also found that prices, food safety issues and health concerns impact differently in the various regions in Canada. As well, education and income levels play an important role in determining the impact of price changes, food safety issues and health concerns on quantity consumed of the different cuts.

### 6.3 Comparison of Time Series and Cross Sectional Results

Both aggregated and microdata are useful for different purposes; the analysis of time series data allows the researcher to identify consumption trends and to study the impact of different issues on aggregated demand for a commodity, while cross sectional estimation provides insights into the differences in demand for less aggregated commodities across individuals at a moment in time. Table 6-1 provides a comparison of per capita disappearance of beef, pork and chicken to household consumption of the different meats considered for the cross sectional estimation of this thesis. Household consumption of the different meats was expected to be smaller than per capita disappearance. Disappearance takes into account all slaughtered meat that goes not only to grocery stores to be sold as fresh or frozen meat, but also meat that is further processed (i.e. cooked meat, ready to eat meals) and meat sold directly to the food service sector.

Household per capita consumption of the different meats only takes into account meat bought by households as fresh or frozen meat.

Table 6-1 Comparison of annual per capita meat disappearance and annual household meat consumption, 1996 and 2001

| 1996 | | | | | 2001 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Disappearance | | Food Expenditure Survey | | | Disappearance | | Food Expenditure Survey | | |
| | kg | | kg | kg | | kg | | kg | kg |
| | | BHV | 6.7 | | | | BHV | 5.3 | |
| Beef | 35.6 | BLV | 12.2 | 19.0 | Beef | 30.2 | BLV | 9.2 | 14.5 |
| | | PHV | 5.4 | | | | PHV | 5.1 | |
| Pork | 27.7 | PLV | 1.3 | 6.8 | Pork | 30.6 | PLV | 1.5 | 6.6 |
| Chicken | 25.3 | P | 18.1 | | Chicken | 30.9 | P | 15.9 | |
| | | OM | 1.7 | | | | OM | 1.3 | |

Note: BHV, BLV, PHV, PLV, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats
Source: disappearance calculated with information from Statistics Canada and Agriculture and Agri-Food Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources. The 1996 and 2001 Food Expenditure Surveys provide household meat consumption.

The comparison of the estimation results obtained from the two different data sets only aims to give an idea of the possible differences and similarities between time series and cross sectional elasticity estimates, mainly focusing on the direction and the significance of the impacts, not on the magnitude of them. Although Bunting (1989) looked at the consumption function "paradox" at the macro level and the difference in marginal propensity to consume and income elasticities, he states that for valid comparisons between time series and cross sectional estimates, the spending units should be the same and on the basis of household or aggregate spending, not comparing household to aggregate spending, involving some data conversion to achieve the desired comparison units. He goes on to state that "the differences in the two types of estimates (time series and cross sectional) might be explained by circumstances such as data quality or statistical procedures rather than behavioral factors" (Bunting, 1989). De Crombrugghe, Palm and Urbain (1997) found similar income elasticity estimates for both their cross sectional and time series estimates when looking at demand functions for food in the US and the Netherlands. Heien and Durham (1991) looked at the effect of the inclusion of a lagged dependant variable to test for habit formation and the differences when using time series and cross sectional data. They found differences in the magnitude of the coefficient estimates between the two data sets but report that both estimations indicate the presence and significance of habit formation in demand. Blundell et al. (1993) report cross sectional and time series estimates of own-price elasticities for a series of goods, stating similarities between micro and aggregate equations, but pointing to the differences in the income elasticities estimated. They conclude by proposing a set of computable aggregation factors in order to avoid parameter instability. Although the purposes of the cited studies are different from the present work, the bottom line is: comparisons between estimates obtained from different data sets require the homologation of units prior to the estimation procedure and the estimates are not necessarily expected to be smaller or greater with either data set. Table 6-2 presents the time series and cross sectional own-price elasticity estimates obtained in this study.

Table 6-2 Time series and cross sectional own-price elasticity estimates for Canada

| | Time Series | | Cross Sectional 1996 | Cross Sectional 2001 |
|---|---|---|---|---|
| **Beef** | -0.428 *** | **BHV** | -1.731 *** | -1.431 *** |
| | [-7.821] | | [-31.189] | [-20.3549] |
| **Pork** | -0.363 *** | **BLV** | -1.287 *** | -1.336 *** |
| | [-5.361] | | [-37.626] | [-22.5793] |
| **Chicken** | -0.463 | **PHV** | -1.669 *** | -1.758 *** |
| | [-6.816] *** | | [-25.120] | [-20.3617] |
| | | **PLV** | -2.557 *** | -3.343 *** |
| | | | [-10.794] | [-9.61612] |
| | | **P** | -1.233 *** | -1.197 *** |
| | | | [-49.624] | [-38.9622] |
| | | **OM** | -2.191 *** | -2.050 *** |
| | | | [-17.373] | [-11.0936] |

Note: BHV, BLV, PHV, PLV, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats.
*** indicate significance at the 1 percent level.
Values in square brackets are t-statistics

Compared to time series own-price elasticities, micro-data estimates are much greater in absolute value terms. One of the possible reasons for having such variation is that, on a day to day basis, people are confronted with the possibility of getting meat products on promotion at the grocery store, which may have an impact on their decision to considerably increase the quantity of meat that they get (i.e. a "buy one get one free" promotion at the meat counter). If one considers in the same dataset a person who got a "buy one get one free" promotion at a grocery store and a person who paid the normal price at a different outlet, it would appear that the quantity consumed is highly reactive to price. Moreover, processors who carry out further meat processing and food service establishments would be less reactive to price than the average consumer; they still have to meet their production and sales goals, and may be able to cushion some price changes.

Tables 6-3 and 6-4 provide the food safety and health elasticities for both estimations (time series and cross sectional). It is only with the cross sectional data that we find food safety having significant impacts on Canadian meat consumption in both 1996 and 2001. The time series database used for this study goes from 1978 to 2001. Having such a long data period, it might be difficult to capture food safety issues that have been focused later in the period. On the other hand, the media coverage considered to build the BSE food safety index mostly refers to foreign issues (Figure 6-1). Hence, Canadians may have felt 'safe' and not adjusted consumption. For example, the British government announced in 1996 the possible relationship between BSE and the human encephalopathy associated with eating contaminated beef. The cross section estimation reflects a possible public reaction to such an announcement and provides bigger food safety elasticities for 1996 as compared to 2001.

Table 6-3 Time series and cross sectional food safety elasticity estimates for Canada

| | | Cross Sectional | | |
|---|---|---|---|---|
| | **Time Series** | | **1996** | **2001** |
| **Beef** | 0.001 | **BHV** | -0.040 *** | -0.018 ** |
| | [0.415] | | [-3.377] | [-2.247] |
| **Pork** | -0.002 | **BLV** | -0.068 *** | -0.024 ** |
| | [-0.728] | | [-3.377] | [-2.247] |
| **Chicken** | 0.017 | **PHV** | -0.030 *** | -0.015 ** |
| | [1.359] | | [-3.377] | [-2.247] |
| | | **PLV** | -0.005 *** | -0.002 ** |
| | | | [-3.377] | [-2.247] |
| | | **P** | -0.071 *** | -0.035 ** |
| | | | [-3.377] | [-2.247] |
| | | **OM** | -0.009 *** | -0.004 ** |
| | | | [-3.377] | [-2.247] |

Note: BHV, BLV, PHV, PLV, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats.
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics

With respect to the health elasticities, we find that, with the time series data, beef and pork consumption are significantly impacted by health information and that with cross section data health information has a significant impact on household consumption of meats only in 1996. Health information has been published more frequently than food safety in the news during the time series sample period, which could be the reason health information has some significant effects on consumption. The increasing information available in the news about eating healthier and about the relationships between some foods and the risk of developing a specific disease is sometimes confusing and contradictory. The impact of this information might diminish through time and the public might believe that following the news might not be the best thing to do. Data on household consumption of meats may reflect this 'information saturation' effect.

Table 6-4 Time series and cross sectional health elasticity estimates for Canada

| | Time Series | | | Cross Sectional | | |
|---|---|---|---|---|---|---|
| | | | | 1996 | | 2001 |
| **Beef** | 0.032 | ** | **BHV** | 0.00138 | *** | 0.00017 |
| | [2.492] | | | [2.653] | | [0.728] |
| **Pork** | 0.081 | ** | **BLV** | 0.00234 | *** | 0.00022 |
| | [2.034] | | | [2.653] | | [0.728] |
| **Chicken** | -0.014 | | **PHV** | 0.00104 | *** | 0.00013 |
| | [-0.225] | | | [2.653] | | [0.728] |
| | | | **PLV** | 0.00018 | *** | 0.00002 |
| | | | | [2.653] | | [0.728] |
| | | | **P** | 0.00245 | *** | 0.00032 |
| | | | | [2.653] | | [0.728] |
| | | | **OM** | 0.00030 | *** | 0.00004 |
| | | | | [2.653] | | [0.728] |

Note: BHV, BLV, PHV, PLV, P and OM stand for Beef High Value, Beef Low Value, Pork High Value, Pork Low Value, Poultry and Other Meats.
*** and ** indicate significance at the 1 and 5 percent level, respectively.
Values in square brackets are t-statistics

Again, as with the price elasticities, there is some variation with respect to the magnitude of the estimates between time series and cross sectional estimations. The culprit of this discrepancy may be the differences in aggregation. Although the impacts vary in size, it is worth noting that the stability of the price- and some of the health-impacts across studies suggest a role of both price and informational factors in consumer decision making.

### 6.4 Implications

The food industry in general and the beef industry more specifically have been trying to expand sales by using a series of marketing strategies. From producer funded advertising aimed at increasing sales of a generic product to fast food restaurant promotion dedicated to increasing the appeal of prepared meals, the generalized intention has been to increase the size of the market. Marketing institutions funded by producers (i.e. Beef Information Centre) have also tried to increase the demand for meat showcasing it as a healthy and nutritious food.

Generic, brand and restaurant advertising have significantly increased beef sales, while net health information has had a positive impact on beef consumption. On the other hand, up until 2001 food safety issues were not seen to have an impact on aggregate meat consumption.

Demographic characteristics play an important role in determining the demand for meat in Canada. The industry has to take into account differences across individuals to get the most out of its marketing programs; targeting markets according to the issues that matter to a segment of the population the most. For example, highly educated and high income people are the least responsive to changes in the price of high value cuts of beef. At the same time the same segment of the population is the most responsive to food safety issues and health concerns with respect to the mentioned cuts. Thus, it would make sense to focus marketing efforts on showcasing high value cuts of beef as safe and healthy to highly educated and high income people. Meanwhile, less educated and low income people are more reactive to safety and health issues with respect to beef low value cuts, and are less reactive to price changes of these cuts than other population segments. This may also be taken into account to direct the efforts of the industry.

The results obtained in this thesis may help to shed some light on what happened during the Canadian BSE crisis in 2003. Despite the efforts of the industry to move an increased quantity of beef low value cuts by decreasing price, the increase in the quantity of beef marketed was slight. Total beef disappearance increased only 8.25 percent in the third quarter of 2003 with respect to the same quarter of 2002, and only a fraction of total disappearance is considered low value cuts. This situation may be due to the fact that people who consume low value cuts the most are the least price sensitive (less educated, low income households), as well as the most food safety concerned with respect to such beef products.

This study indicates that there are some policy implications to be considered. From the time series analysis, it is found that changes in food serving recommendations published in the different Canadian food guides have had a negative impact on total expenditure on meat. If such recommendations are based on science, leading to improvements in public health through food intake and have an impact on the demand for foods, and specifically for meat, the capacity of commodity groups to intervene in the process of the creation of the guide should be limited. If Canadians are getting the message and changing their consumption patterns accordingly, the food guide must be a sound nutritional tool obeying science, not politics.

The other important policy implication of this thesis is the one about information. Media have an effect on consumption patterns. Food safety and health information are both significant for consumer decision making. The government has the responsibility to ensure that the public is getting the right information, so that consumers can make the best decisions using such resources. If there is misleading or incorrect information, there may be a role to be filled by the government in providing correct information.

### 6.5 Beef Consumption

Canadian per capita beef disappearance has been declining since the late 1970's, but what has been causing the decline in beef consumption in Canada? From the simulation results, we know that per capita beef consumption would be at higher levels today if relative pork and chicken prices had been higher, and if beef producers, processors and fast food restaurant chains had expended more on generic, brand and restaurant advertising, respectively. Health information has also played an important role in determining Canadian beef demand, if the number of negative beef health articles had been lower, leading the beef net health index to increase, beef consumption would have been at higher levels. As well, if the number of positive pork and chicken health articles had been lower, leading the pork and chicken net health indices to decline, beef consumption would not have declined as much as it did.

From 1976 to 2001, real pork and chicken prices have actually gone down by 26 and 17 percent, respectively, while real beef price has increased by 14 percent. These relative price changes represent a gap of 40 percent between the real price of beef and pork, and of 32 percent between the real price of beef and chicken. The results show that relative prices matter, thus it is likely that changes in prices may have caused Canadian beef consumption to decrease.

Marketing efforts by the different beef industry levels have been found to significantly affect beef consumption. However, if pork producers had decided not to increase investment levels on generic pork advertising, beef consumption would not have declined as much as it did.

Health concerns have been important in determining Canadian beef demand. Consumers have been influenced by media reports on the different meats and health, and have taken such information into account when making meat purchasing decisions. Beef, pork and chicken health information have affected beef consumption in Canada.

Demographics have also played a role in determining beef consumption in Canada. Aging has a negative and significant effect on consumption of beef low value cuts. Canada's median age went up from 25.4 years in 1966 to 37.6 years in 2001. Given that aging is important for beef consumption, promotion strategies aimed at increasing the appeal of beef for Canadian adults would be a good marketing strategy for the beef industry. Household size has had a positive impact on beef low value cut consumption and a negative effect on beef high value cut consumption, bigger households are more income-constrained than households with fewer people. Since average family size decreased from 3.7 in 1971 to 3 in 2000, there may be increased demand for beef high value cuts in the future. Although working on production systems that could decrease the cost of producing beef would be a good strategy for the Canadian beef industry in order to increase beef consumption, looking at the level of market power that processors and retailers have would provide information on how effective a decrease in the farm cost of production would ultimately be reflected in consumers' pockets.

## 6.6 Contribution

No previous work, in Canada or elsewhere, has specified a demand system taking into account all the sources of media information that this study has considered. This research takes into account generic advertising, brand advertising, fast food restaurant advertising, food safety issues and health concerns to determine the demand for meat in Canada. Although information indices have been used before to conduct food (meat) demand analyses, no study has built food safety and health indices specific to every meat type. The closest study would be the one by Piggott and Marsh (2004) who constructed food safety indices for beef, pork and poultry, but did not take into account health information or any kind of advertising.

Another contribution of this study is that it looked at the impact of demographic characteristics on the demand for meat in Canada. Results indicate that different segments of the population react differently to prices, food safety and health concerns. These differences have to be taken into account by industry players in directing marketing strategies. No previous published study has looked at survey data to estimate the demand for meat in Canada.

### 6.7 Further Research

There are some recommendations for further research. The possible impact of the single BSE case on Canadian meat demand calls for further empirical analysis. For the time series estimation, this study considered data up to 2001, updating the databases up to 2003 and running a new analysis including all the information variables used in this study could shed more light on what really happened to Canadian meat demand during this time.

There is also the possibility of including other meats in the time series analysis. Using not only beef, pork and chicken, but also turkey, lamb and/or fish (or seafood), could provide some more information on the substitutability of meats in Canada. This would be useful for the complete meat industry in order to establish adequate marketing strategies.

There is increasingly more preoccupation about using the AIDS model for food demand. The AIDS model has been around for approximately 24 years; theoretical and computational advances call for the use of demand models that could be more representative of consumer behaviour. Using the FES data with an enhanced model structure is one of the possible extensions to this study.

The zero expenditure issue in cross sectional estimation is an important one. Addressing it with the use of full-information-maximum-likelihood techniques (FIML) would be the best empirical option thus far. Using this method for the estimation of systems of equations remains difficult (Shonkwiler and Yen, 1999), but it would be worth to do so and deal with this problem in the best possible way.

Only one set of parameters per dataset was used to calculate the correspondent elasticities. Breaking down the samples into different time periods (in the case of the time series data) or into different regions or educational levels (in the case of the cross sectional data) could provide more accurate elasticities of demand for a specific time period or a specific region. Obtaining parameter estimates for specific sample periods, regions or educational levels and then calculating the corresponding elasticities using such parameters would be an extension to this research.

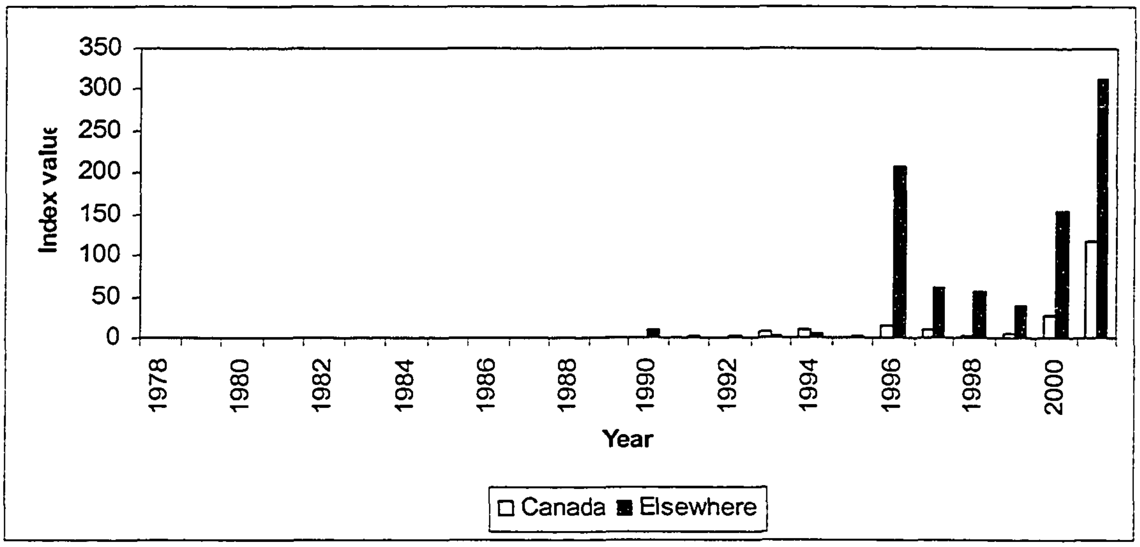
It is important to note that the Food Safety Indices built and used in the empirical estimation of this study consider articles published in Canadian publications but may consider issues from outside Canada. Figures 6-1 to 6-6 show the number of food safety media indices for Canada and Elsewhere. A possibility for further research would be to differentiate between Canadian and foreign issues and see what the effect of domestic and international food safety scares has been on Canadian meat demand.

In the case of the Health Indices, a net index (positive – negative) was built for each meat type. Further research could be done on trying different weighting procedures. For example, there is the possibility that negative news could have a greater impact on consumer perceptions than positive news. Giving different weights to news reports depending on if negative or positive is an avenue for further investigation.

The only source of social marketing considered for the estimation purposes of this thesis was the Canadian Food Guide to Healthy Eating. Social marketing efforts made by groups such as the Canadian Cancer Society or the Heart and Stroke foundation of Canada could be incorporated in a model to capture the impact of other social marketing campaigns on Canadian meat consumption.

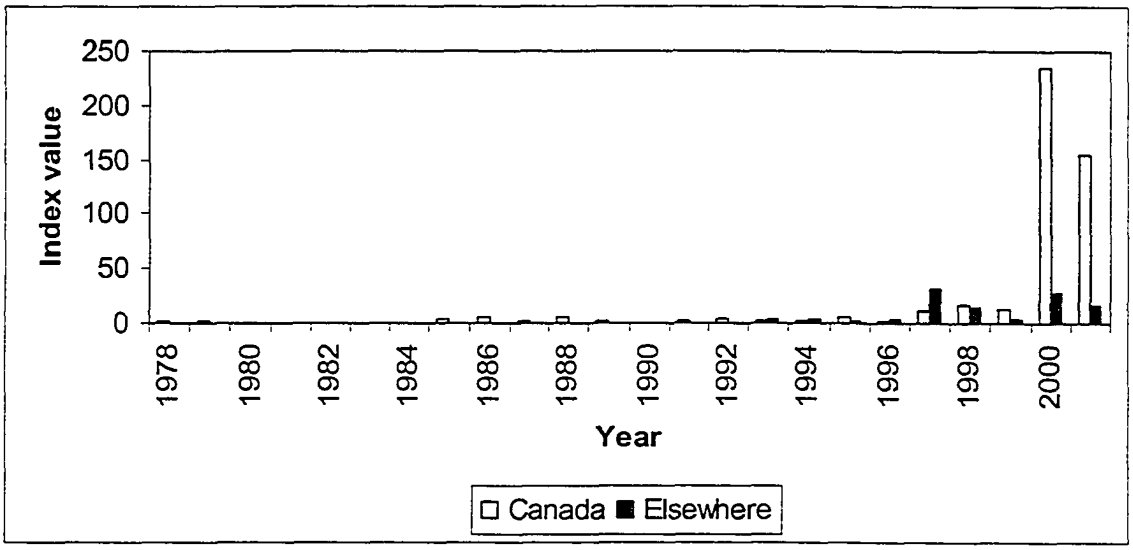
Advertising expenditures were incorporated independently in the model specification of this thesis. Interactive effects of all media influences could also be included to capture interactions among the different sources of advertising expenditures in the Canadian meat industry.

Figure 6-1 BSE and beef, Canadian vs. foreign issues, 1978 - 2001



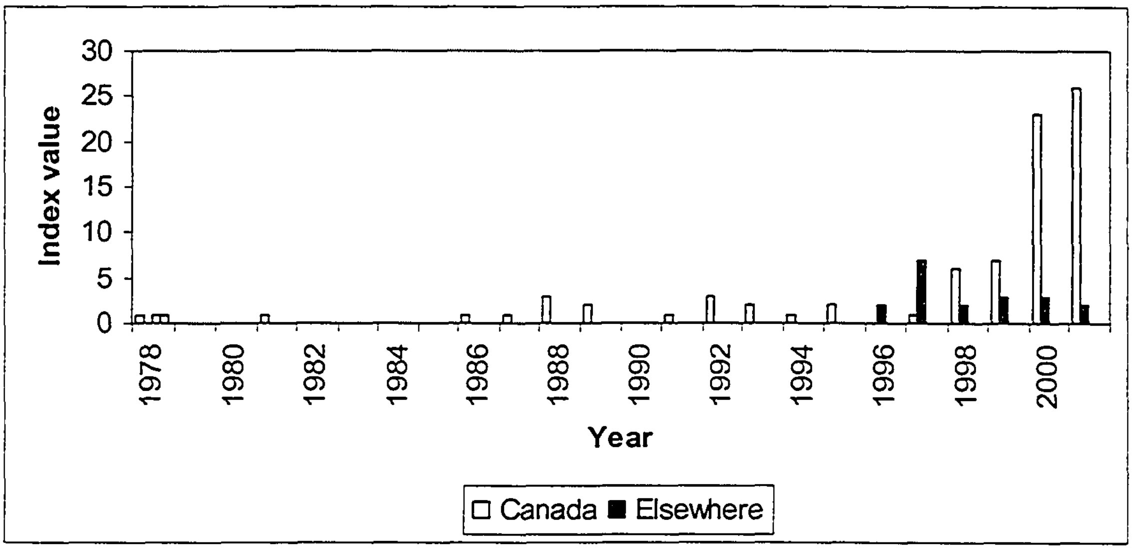

Source: Dow Jones Interactive, number of newspaper articles referring to BSE and beef

Figure 6-2 E. coli and beef, Canadian vs. foreign issues, 1978-2001



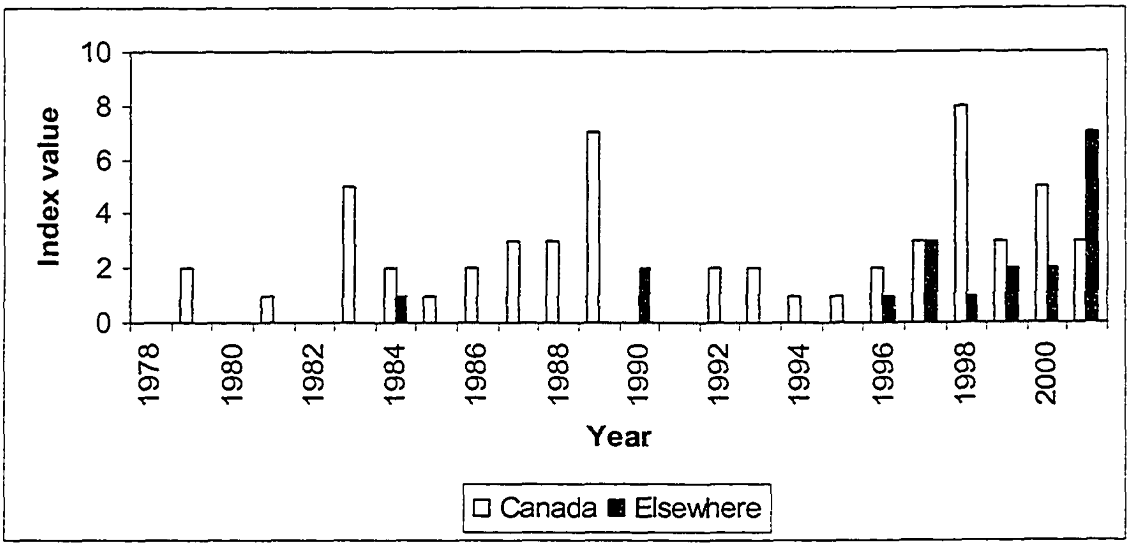

Source: Dow Jones Interactive, number of newspaper articles referring to E. coli and beef

Figure 6-3 E. coli and pork, Canadian vs. foreign issues, 1978-2001



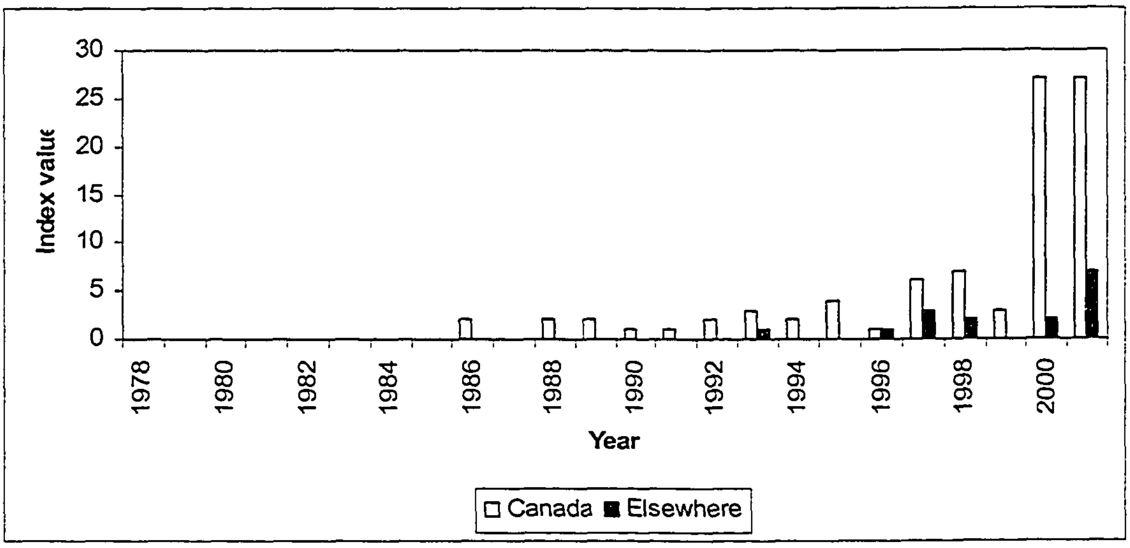

Source: Dow Jones Interactive, number of newspaper articles referring to E. coli and pork

Figure 6-4 Salmonella and pork, Canada vs. foreign issues, 1978 – 2001



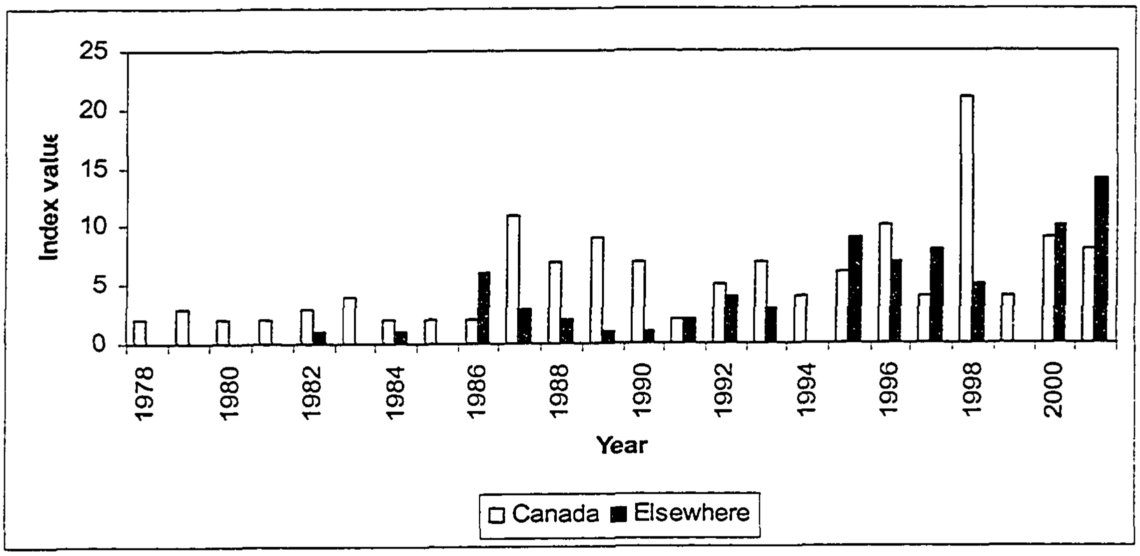

Source: Dow Jones Interactive, number of newspaper articles referring to Salmonella and pork

Figure 6-5 E. coli and chicken, Canada vs. foreign issues, 1978 – 2001




Source: Dow Jones Interactive, number of newspaper articles referring to E. coli and chicken

Figure 6-6 Salmonella and chicken, Canada vs. foreign issues, 1978 – 2001




Source: Dow Jones Interactive, number of newspaper articles referring to Salmonella and chicken.

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# Appendix A

**Derivation of Elasticities**

Following Amuah (1985), who based his work on Berndt, Darrough and Diewert (1977), we have:

From Roy's Identity,

$$Q_i = \frac{\partial\psi / \partial X_i}{\sum_j (X_j \cdot \partial\psi / \partial X_j)}$$

Defining some recurrent terms,

$$h_i = \partial\psi / \partial X_i$$

$$h_j = \partial\psi / \partial X_j$$

$$g = \sum_i X_i h_i$$

$$h_{ij} = \frac{\partial^2 \psi}{\partial X_i \partial X_j} = \frac{\partial(\partial\psi / \partial X_i)}{\partial X_j}$$

$$g_i = \sum_j X_j h_{ij}$$

Then,

$Q_i = h_i / g$, and

$$\frac{\partial Q_i}{\partial X_i} = \frac{h_{ii}}{g} - \frac{Q_i h_i}{g} - \frac{Q_i g_i}{g}$$

Price elasticities

Cross-price elasticities are derived as follows:

$$e_{ij} = \frac{\partial Q_i}{\partial X_j} \cdot \frac{X_j}{Q_i} = \frac{X_j h_{ij}}{h_i} - \frac{X_j h_j}{g} - \frac{X_j g_j}{g}$$

Own-price elasticities are:

$$e_{ii} = \frac{\partial Q_i}{\partial X_i} \cdot \frac{X_i}{Q_i} = \frac{X_i h_{ii}}{h_i} - \frac{X_i h_i}{g} - \frac{X_i g_i}{g}$$

Assuming that the demand functions are homogeneous of degree zero in prices and expenditure, the expenditure elasticities are:

$e_{iy} = -\sum_j e_{ij}$ (Minus the sum of all price elasticities for the $i^{th}$ good)

Advertising elasticities

Cross-generic advertising elasticities:

$$ga_{ij} = \frac{\partial Q_i}{\partial GAD_j} \cdot \frac{\partial GAD_j}{Q_i}$$

Own-generic advertising elasticities:

$$ga_{ii} = \frac{\partial Q_i}{\partial GAD_i} \cdot \frac{\partial GAD_i}{Q_i}$$

Cross-brand advertising elasticities:

$$ba_{ij} = \frac{\partial Q_i}{\partial BAD_j} \cdot \frac{\partial BAD_j}{Q_i}$$

Own-brand advertising elasticities:

$$ba_{ii} = \frac{\partial Q_i}{\partial BAD_i} \cdot \frac{\partial BAD_i}{Q_i}$$

Cross-restaurant advertising elasticities:

$$ra_{ij} = \frac{\partial Q_i}{\partial RAD_j} \cdot \frac{\partial RAD_j}{Q_i}$$

Own-restaurant advertising elasticities:

$$ra_{ii} = \frac{\partial Q_i}{\partial RAD_i} \cdot \frac{\partial RAD_i}{Q_i}$$

Indices elasticities

Cross-food safety elasticities:

$$fs_{ij} = \frac{\partial Q_i}{\partial FSI_j} \cdot \frac{\partial FSI_j}{Q_i}$$

Own-food safety elasticities:

$$fs_{ii} = \frac{\partial Q_i}{\partial FSI_i} \cdot \frac{\partial FSI_i}{Q_i}$$

Cross-health elasticities:

$$hi_{ij} = \frac{\partial Q_i}{\partial HI_j} \cdot \frac{\partial HI_j}{Q_i}$$

Own-health elasticities:

$$hi_{ii} = \frac{\partial Q_i}{\partial HI_i} \cdot \frac{\partial HI_i}{Q_i}$$

Expanding all the above formulas we get:

$$h_i = \partial\psi / \partial X_i = \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1}(X_j^{\lambda} - 1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda-1}(GAD_j^{\lambda} - 1)/\lambda$$

$$+ \sum_j \phi_{ij} X_i^{\lambda-1}(BAD_j^{\lambda} - 1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda-1}(RAD_j^{\lambda} - 1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda-1}(FSI_j^{\lambda}-1)/\lambda+\sum_j \rho_{ij} X_i^{\lambda-1}(HI_j^{\lambda}-1)/\lambda$$

$$h_j=\partial\psi/\partial X_j=\alpha_j X_j^{\lambda-1}+\sum_i \beta_{ij} X_j^{\lambda-1}(X_i^{\lambda}-1)/\lambda+\sum_i \mu_{ij} X_j^{\lambda-1}(GAD_i^{\lambda}-1)/\lambda$$

$$+\sum_i \phi_{ij} X_j^{\lambda-1}(BAD_i^{\lambda}-1)/\lambda+\sum_i \vartheta_{ij} X_j^{\lambda-1}(RAD_i^{\lambda}-1)/\lambda$$

$$+\sum_i \tau_{ij} X_j^{\lambda-1}(FSI_i^{\lambda}-1)/\lambda+\sum_i \rho_{ij} X_j^{\lambda-1}(HI_i^{\lambda}-1)/\lambda$$

$$g=\sum_i X_i h_i=\sum_i \Big[\alpha_i X_i^{\lambda}+\sum_j \beta_{ij} X_i^{\lambda}(X_j^{\lambda}-1)/\lambda+\sum_j \mu_{ij} X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij} X_i^{\lambda}(BAD_j^{\lambda}-1)/\lambda+\sum_j \vartheta_{ij} X_i^{\lambda}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda}(FSI_j^{\lambda}-1)/\lambda+\sum_j \rho_{ij} X_i^{\lambda}(HI_j^{\lambda}-1)/\lambda \ \Big]$$

$$h_{ij}(j\neq i)=\frac{\partial^2\psi}{\partial X_i \partial X_j}=\partial/\partial X_j(\partial\psi/\partial X_i)=\beta_{ij} X_i^{\lambda-1} X_j^{\lambda-1}=h_{ji}$$

$$h_{ij}(j=i)=h_{ii}=\frac{\partial^2\psi}{\partial X_i^2}=\partial/\partial X_i(\partial\psi/\partial X_i)=(\lambda-1)\alpha_i X_i^{\lambda-2}+\sum_j \beta_{ij}(\lambda-1)X_i^{\lambda-2}(X_j^{\lambda}-1)/\lambda$$

$$+\beta_{ii} X_i^{2(\lambda-1)}+\sum_j \mu_{ij}(\lambda-1)X_i^{\lambda-2}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij}(\lambda-1)X_i^{\lambda-2}(BAD_j^{\lambda}-1)/\lambda+\sum_j \vartheta_{ij}(\lambda-1)X_i^{\lambda-2}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij}(\lambda-1)X_i^{\lambda-2}(FSI_j^{\lambda}-1)/\lambda+\sum_j \rho_{ij}(\lambda-1)X_i^{\lambda-2}(HI_j^{\lambda}-1)/\lambda$$

$$g_i=\sum_j X_j h_{ij}=\sum_j \big[\ \beta_{ij} X_i^{\lambda-1} X_j^{\lambda}+(\lambda-1)\alpha_i X_i^{\lambda-1}+\sum_j \beta_{ij}(\lambda-1)X_i^{\lambda-1}(X_j^{\lambda}-1)/\lambda$$

$$+\beta_{ii} X_i^{2\lambda-1}+\sum_j \mu_{ij}(\lambda-1)X_i^{\lambda-1}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij}(\lambda-1)X_i^{\lambda-1}(BAD_j^{\lambda}-1)/\lambda+\sum_j \vartheta_{ij}(\lambda-1)X_i^{\lambda-1}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij}(\lambda-1)X_i^{\lambda-1}(FSI_j^{\lambda}-1)/\lambda+\sum_j \rho_{ij}(\lambda-1)X_i^{\lambda-1}(HI_j^{\lambda}-1)/\lambda \ ]$$

$$=\sum_j \beta_{ij}X_i^{\lambda-1}X_j^{\lambda}+(\lambda-1)\alpha_i X_i^{\lambda-1}$$

$$+\sum_j \beta_{ij}(\lambda-1)X_i^{\lambda-1}(X_j^{\lambda}-1)/\lambda+\sum_j \mu_{ij}(\lambda-1)X_i^{\lambda-1}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij}(\lambda-1)X_i^{\lambda-1}(BAD_j^{\lambda}-1)/\lambda+\sum_j \vartheta_{ij}(\lambda-1)X_i^{\lambda-1}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij}(\lambda-1)X_i^{\lambda-1}(FSI_j^{\lambda}-1)/\lambda+\sum_j \rho_{ij}(\lambda-1)X_i^{\lambda-1}(HI_j^{\lambda}-1)/\lambda$$

Similarly,

$$g_j=\sum_i \beta_{ij}X_j^{\lambda-1}X_i+(\lambda-1)\alpha_j X_j^{\lambda-1}$$

$$+\sum_i \beta_{ij}(\lambda-1)X_j^{\lambda-1}(X_i^{\lambda}-1)/\lambda+\sum_i \mu_{ij}(\lambda-1)X_j^{\lambda-1}(GAD_i^{\lambda}-1)/\lambda$$

$$+\sum_i \phi_{ij}(\lambda-1)X_j^{\lambda-1}(BAD_i^{\lambda}-1)/\lambda+\sum_i \vartheta_{ij}(\lambda-1)X_j^{\lambda-1}(RAD_i^{\lambda}-1)/\lambda$$

$$+\sum_i \tau_{ij}(\lambda-1)X_j^{\lambda-1}(FSI_i^{\lambda}-1)/\lambda+\sum_i \rho_{ij}(\lambda-1)X_j^{\lambda-1}(HI_i^{\lambda}-1)/\lambda$$

From the expanded terms and the elasticity formulas we get:

Price elasticities

Cross-price elasticities:

$$e_{ij}=\frac{X_j h_{ij}}{h_i}-\frac{X_j h_j}{g}-\frac{X_j g_j}{g}$$

$$=[\ \beta_{ij}X_i^{\lambda-1}X_j^{\lambda}\ /$$

$$(\alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1}(X_j^{\lambda}-1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda-1}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij} X_i^{\lambda-1}(BAD_j^{\lambda}-1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda-1}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda-1}(FSI_j^{\lambda}-1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda-1}(HI_j^{\lambda}-1)/\lambda) \;]$$

$$-\;[\;(\alpha_j X_j^{\lambda} + \sum_i \beta_{ij} X_j^{\lambda}(X_i^{\lambda}-1)/\lambda + \sum_i \mu_{ij} X_j^{\lambda}(GAD_i^{\lambda}-1)/\lambda$$

$$+\sum_i \phi_{ij} X_j^{\lambda}(BAD_i^{\lambda}-1)/\lambda + \sum_i \vartheta_{ij} X_j^{\lambda}(RAD_i^{\lambda}-1)/\lambda$$

$$+\sum_i \tau_{ij} X_j^{\lambda}(FSI_i^{\lambda}-1)/\lambda + \sum_i \rho_{ij} X_j^{\lambda}(HI_i^{\lambda}-1)/\lambda\,)\,/$$

$$(\sum_i \big[\alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda}(X_j^{\lambda}-1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij} X_i^{\lambda}(BAD_j^{\lambda}-1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda}(FSI_j^{\lambda}-1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda}(HI_j^{\lambda}-1)/\lambda \;\big]) \;]$$

$$-\;[\;(\sum_i \beta_{ij} X_j^{\lambda-1} X_i^{\lambda} + (\lambda-1)\alpha_j X_j^{\lambda}$$

$$+\sum_i \;\beta_{ij}(\lambda-1) X_j^{\lambda-1}(X_i^{\lambda}-1)/\lambda + \sum_i \mu_{ij}(\lambda-1) X_j^{\lambda-1}(GAD_i^{\lambda}-1)/\lambda$$

$$+\sum_i \phi_{ij}(\lambda-1) X_j^{\lambda-1}(BAD_i^{\lambda}-1)/\lambda + \sum_i \vartheta_{ij}(\lambda-1) X_j^{\lambda-1}(RAD_i^{\lambda}-1)/\lambda$$

$$+\sum_i \tau_{ij}(\lambda-1) X_j^{\lambda-1}(FSI_i^{\lambda}-1)/\lambda + \sum_i \rho_{ij}(\lambda-1) X_j^{\lambda-1}(HI_i^{\lambda}-1)/\lambda\,)\;/$$

$$(\sum_i \big[\alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda}(X_j^{\lambda}-1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \;]) \;\; ]$$

Own-price elasticities:

$$e_{ii} = \frac{X_i h_{ii}}{h_i} - \frac{X_i h_i}{g} - \frac{X_i g_i}{g}$$

$$=[ \; ( (\lambda - 1)\alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} (\lambda - 1) X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda$$

$$+\beta_{ii} X_i^{2\lambda-1} + \sum_j \mu_{ij} (\lambda - 1) X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda$$

$$+\sum_j \phi_{ij} (\lambda - 1) X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda + \sum_j \vartheta_{ij} (\lambda - 1) X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda$$

$$+\sum_j \tau_{ij} (\lambda - 1) X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda + \sum_j \rho_{ij} (\lambda - 1) X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \,) \, /$$

$$(\alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda$$

$$+\sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda) \;\; ]$$

$$- [ \;\; (\alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda$$

$$+\sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \,) \, /$$

$$(\sum_i \Big[\alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda}(X_j^{\lambda}-1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij} X_i^{\lambda}(BAD_j^{\lambda}-1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda}(FSI_j^{\lambda}-1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda}(HI_j^{\lambda}-1)/\lambda \;\Big]) \quad ]$$

$$-\;[\;\;(\sum_j \beta_{ij} X_i^{\lambda} X_j^{\lambda} + (\lambda-1)\alpha_i X_i^{\lambda}$$

$$+\sum_j \;\beta_{ij}(\lambda-1)X_i^{\lambda}(X_j^{\lambda}-1)/\lambda + \sum_j \mu_{ij}(\lambda-1)X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij}(\lambda-1)X_i^{\lambda}(BAD_j^{\lambda}-1)/\lambda + \sum_j \vartheta_{ij}(\lambda-1)X_i^{\lambda}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij}(\lambda-1)X_i^{\lambda}(FSI_j^{\lambda}-1)/\lambda + \sum_j \rho_{ij}(\lambda-1)X_i^{\lambda}(HI_j^{\lambda}-1)/\lambda\,)\,/$$

$$(\sum_i \Big[\alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda}(X_j^{\lambda}-1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \phi_{ij} X_i^{\lambda}(BAD_j^{\lambda}-1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda}(RAD_j^{\lambda}-1)/\lambda$$

$$+\sum_j \tau_{ij} X_i^{\lambda}(FSI_j^{\lambda}-1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda}(HI_j^{\lambda}-1)/\lambda \;\Big]) \quad ]$$

Media Elasticities

The quantity equation with the three kinds of advertising and the media indices is specified as:

$$Q_i = \frac{\begin{array}{l}\alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1}(X_j^{\lambda}-1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda-1}(GAD_j^{\lambda}-1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1}(BAD_j^{\lambda}-1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda-1}(RAD_j^{\lambda}-1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1}(FSI_j^{\lambda}-1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda-1}(HI_j^{\lambda}-1)/\lambda\end{array}}{\sum_i \left[\begin{array}{l}\alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda}(X_j^{\lambda}-1)/\lambda + \sum_j \mu_{ij} X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda}(BAD_j^{\lambda}-1)/\lambda + \sum_j \vartheta_{ij} X_i^{\lambda}(RAD_j^{\lambda}-1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda}(FSI_j^{\lambda}-1)/\lambda + \sum_j \rho_{ij} X_i^{\lambda}(HI_j-1)/\lambda\end{array}\right]}$$

Let,

$$Q_i = N(GAD_i, BAD_i, RAD_i, FSI_i, HI_i) / D(GAD_i, BAD_i, RAD_i, FSI_i, HI_i)$$

For cross-media elasticities,

$$\frac{\partial Q_i}{\partial Media_j} = \frac{D(\partial N / \partial Media_j) - N(\partial D / \partial Media_j)}{D^2} = \frac{DN' - ND'}{D^2}$$

Where $Media$ could be $GAD, BAD, RAD, FSI$ or $HI$

In the case of generic advertising,

$$N' = \mu_{ij} X_i^{\lambda-1} GAD_j^{\lambda-1}$$

$$D' = \sum_i (\mu_{ij} X_i^{\lambda-1} GAD_j^{\lambda-1})$$

In the case of brand advertising,

$$N' = \phi_{ij} X_i^{\lambda-1} BAD_j^{\lambda-1}$$

$$D' = \sum_i (\phi_{ij} X_i^{\lambda-1} BAD_j^{\lambda-1})$$

In the case of restaurant advertising,

$$N' = \vartheta_{ij} X_i^{\lambda-1} RAD_j^{\lambda-1}$$

$$D' = \sum_i (\vartheta_{ij} X_i^{\lambda-1} RAD_j^{\lambda-1})$$

In the case of food safety,

$$N' = \tau_{ij} X_i^{\lambda-1} FSI_j^{\lambda-1}$$

$$D' = \sum_i (\tau_{ij} X_i^{\lambda-1} FSI_j^{\lambda-1})$$

In the case of health

$$N' = \rho_{ij} X_i^{\lambda-1} HI_j^{\lambda-1}$$

$$D' = \sum_i (\rho_{ij} X_i^{\lambda-1} HI_j^{\lambda-1})$$

From first principles,

Cross-generic advertising elasticities:

$$ga_{ij} = \frac{\partial Q_i}{\partial GAD_j} \cdot \frac{\partial GAD_j}{Q_i}$$

$$ga_{ij} = \frac{GAD_j \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\mu_{ij} X_i^{\lambda-1} GAD_j^{\lambda-1}\right] - \begin{bmatrix} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\sum_i \left(\mu_{ij} X_i^{\lambda-1} GAD_j^{\lambda-1}\right)\right] \right\}}{Q_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \right\}^2}$$

Cross-brand advertising elasticities:

$$ba_{ij} = \frac{\partial Q_i}{\partial BAD_j} \cdot \frac{\partial BAD_j}{Q_i}$$

$$ba_{ij} = \frac{BAD_j \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\phi_{ij} X_i^{\lambda-1} BAD_j^{\lambda-1}\right] - \begin{bmatrix} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\sum_i \left(\phi_{ij} X_i^{\lambda-1} BAD_j^{\lambda-1}\right)\right] \right\}}{Q_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \right\}^2}$$

Cross-restaurant advertising elasticities:

$$ra_{ij} = \frac{\partial Q_i}{\partial RAD_j} \cdot \frac{\partial RAD_j}{Q_i}$$

$$ra_{ij} = \frac{RAD_j \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\vartheta_{ij} X_i^{\lambda-1} RAD_j^{\lambda-1}\right] - \begin{bmatrix} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\sum_i \left(\vartheta_{ij} X_i^{\lambda-1} RAD_j^{\lambda-1}\right)\right] \right\}}{Q_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \right\}^2}$$

Cross-food safety elasticities:

$$fs_{ij} = \frac{\partial Q_i}{\partial FSI_j} \cdot \frac{\partial FSI_j}{Q_i}$$

$$fs_{ij} = \frac{FSI_j \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[ \tau_{ij} X_i^{\lambda-1} FSI_j^{\lambda-1} \right] - \begin{bmatrix} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[ \sum_i \left( \tau_{ij} X_i^{\lambda-1} FSI_j^{\lambda-1} \right) \right] \right\}}{Q_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \right\}^2}$$

Cross-health elasticities:

$$hi_{ij} = \frac{\partial Q_i}{\partial HI_j} \cdot \frac{\partial HI_j}{Q_i}$$

$$h_{ij} = \frac{HI_j \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[ \rho_{ij} X_i^{\lambda-1} HI_j^{\lambda-1} \right] - \begin{bmatrix} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[ \sum_i \left( \rho_{ij} X_i^{\lambda-1} HI_j^{\lambda-1} \right) \right] \right\}}{Q_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \right\}^2}$$

For own-media elasticities,

$$\frac{\partial Q_i}{\partial Media_i} = \frac{D(\partial N / \partial Media_i) - N(\partial D / \partial Media_i)}{D^2} = \frac{DN' - ND'}{D^2}$$

Where $Media$ could be $GAD, BAD, RAD, FSI$ or $HI$

In the case of generic advertising,

$$N' = \mu_{ii} X_i^{\lambda-1} GAD_i^{\lambda-1}$$

$$D' = \sum_i (\mu_{ii} X_i^{\lambda-1} GAD_i^{\lambda-1})$$

In the case of brand advertising,

$$N' = \phi_{ii} X_i^{\lambda-1} BAD_i^{\lambda-1}$$

$$D' = \sum_i (\phi_{ii} X_i^{\lambda-1} BAD_i^{\lambda-1})$$

In the case of restaurant advertising,

$$N' = \vartheta_{ii} X_i^{\lambda-1} RAD_i^{\lambda-1}$$

$$D' = \sum_i (\vartheta_{ii} X_i^{\lambda-1} RAD_i^{\lambda-1})$$

In the case of food safety,

$$N' = \tau_{ii} X_i^{\lambda-1} FSI_i^{\lambda-1}$$

$$D' = \sum_i (\tau_{ii} X_i^{\lambda-1} FSI_i^{\lambda-1})$$

In the case of health

$$N' = \rho_{ii} X_i^{\lambda-1} HI_i^{\lambda-1}$$

$$D' = \sum_i (\rho_{ii} X_i^{\lambda-1} HI_i^{\lambda-1})$$

Own-generic advertising elasticities:

$$ga_{ii} = \frac{\partial Q_i}{\partial GAD_i} \cdot \frac{\partial GAD_i}{Q_i}$$

$$ga_{ii} = \frac{GAD_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[ \mu_{ii} X_i^{\lambda-1} GAD_i^{\lambda-1} \right] - \begin{bmatrix} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[ \sum_i \left( \mu_{ii} X_i^{\lambda-1} GAD_i^{\lambda-1} \right) \right] \right\}}{Q_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \right\}^2}$$

Own-brand advertising elasticities:

$$ba_{ii} = \frac{\partial Q_i}{\partial BAD_i} \cdot \frac{\partial BAD_i}{Q_i}$$

$$ba_{ii} = \frac{BAD_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\phi_{ii} X_i^{\lambda-1} BAD_i^{\lambda-1}\right] - \begin{bmatrix} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\sum_i \left(\phi_{ii} X_i^{\lambda-1} BAD_i^{\lambda-1}\right)\right] \right\}}{Q_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \right\}^2}$$

Own-restaurant advertising elasticities:

$$ra_{ii} = \frac{\partial Q_i}{\partial RAD_i} \cdot \frac{\partial RAD_i}{Q_i}$$

$$ra_{ii} = \frac{RAD_i \cdot \left\{ \sum_i \left[ \begin{array}{l} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{array} \right] \cdot \left[ \vartheta_{ii} X_i^{\lambda-1} RAD_i^{\lambda-1} \right] - \left[ \begin{array}{l} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{array} \right] \cdot \left[ \sum_i \left( \vartheta_{ii} X_i^{\lambda-1} RAD_i^{\lambda-1} \right) \right] \right\}}{Q_i \cdot \left\{ \sum_i \left[ \begin{array}{l} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{array} \right] \right\}^2}$$

Own-food safety elasticities:

$$fs_{ii} = \frac{\partial Q_i}{\partial FSI_i} \cdot \frac{\partial FSI_i}{Q_i}$$

$$fs_{ii} = \frac{FSI_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\tau_{ii} X_i^{\lambda-1} FSI_i^{\lambda-1}\right] - \begin{bmatrix} \alpha_i X_i^{\lambda-1} + \sum_j \beta_{ij} X_i^{\lambda-1} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda-1} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda-1} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda-1} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda-1} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda-1} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix} \cdot \left[\sum_i \left(\tau_{ii} X_i^{\lambda-1} FSI_i^{\lambda-1}\right)\right] \right\}}{Q_i \cdot \left\{ \sum_i \begin{bmatrix} \alpha_i X_i^{\lambda} + \sum_j \beta_{ij} X_i^{\lambda} (X_j^{\lambda} - 1)/\lambda \\ + \sum_j \mu_{ij} X_i^{\lambda} (GAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \phi_{ij} X_i^{\lambda} (BAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \vartheta_{ij} X_i^{\lambda} (RAD_j^{\lambda} - 1)/\lambda \\ + \sum_j \tau_{ij} X_i^{\lambda} (FSI_j^{\lambda} - 1)/\lambda \\ + \sum_j \rho_{ij} X_i^{\lambda} (HI_j^{\lambda} - 1)/\lambda \end{bmatrix}^2 \right\}}$$

Own-health elasticities:

$$h_{ii}=\frac{HI_i\cdot\left\{\sum_i\begin{bmatrix}\alpha_iX_i^{\lambda}+\sum_j\beta_{ij}X_i^{\lambda}(X_j^{\lambda}-1)/\lambda\\+\sum_j\mu_{ij}X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda\\+\sum_j\phi_{ij}X_i^{\lambda}(BAD_j^{\lambda}-1)/\lambda\\+\sum_j\vartheta_{ij}X_i^{\lambda}(RAD_j^{\lambda}-1)/\lambda\\+\sum_j\tau_{ij}X_i^{\lambda}(FSI_j^{\lambda}-1)/\lambda\\+\sum_j\rho_{ij}X_i^{\lambda}(HI_j^{\lambda}-1)/\lambda\end{bmatrix}\cdot\left[\rho_{ii}X_i^{\lambda-1}HI_i^{\lambda-1}\right]-\begin{bmatrix}\alpha_iX_i^{\lambda-1}+\sum_j\beta_{ij}X_i^{\lambda-1}(X_j^{\lambda}-1)/\lambda\\+\sum_j\mu_{ij}X_i^{\lambda-1}(GAD_j^{\lambda}-1)/\lambda\\+\sum_j\phi_{ij}X_i^{\lambda-1}(BAD_j^{\lambda}-1)/\lambda\\+\sum_j\vartheta_{ij}X_i^{\lambda-1}(RAD_j^{\lambda}-1)/\lambda\\+\sum_j\tau_{ij}X_i^{\lambda-1}(FSI_j^{\lambda}-1)/\lambda\\+\sum_j\rho_{ij}X_i^{\lambda-1}(HI_j^{\lambda}-1)/\lambda\end{bmatrix}\cdot\left[\sum_i\left(\rho_{ii}X_i^{\lambda-1}HI_i^{\lambda-1}\right)\right]\right\}}{Q_i\cdot\left\{\sum_i\begin{bmatrix}\alpha_iX_i^{\lambda}+\sum_j\beta_{ij}X_i^{\lambda}(X_j^{\lambda}-1)/\lambda\\+\sum_j\mu_{ij}X_i^{\lambda}(GAD_j^{\lambda}-1)/\lambda\\+\sum_j\phi_{ij}X_i^{\lambda}(BAD_j^{\lambda}-1)/\lambda\\+\sum_j\vartheta_{ij}X_i^{\lambda}(RAD_j^{\lambda}-1)/\lambda\\+\sum_j\tau_{ij}X_i^{\lambda}(FSI_j^{\lambda}-1)/\lambda\\+\sum_j\rho_{ij}X_i^{\lambda}(HI_j^{\lambda}-1)/\lambda\end{bmatrix}\right\}^2}$$

$$hi_{ii}=\frac{\partial Q_i}{\partial HI_i}\cdot\frac{\partial HI_i}{Q_i}$$

# Appendix B

Beef Disappearance Data Used for the Time Series Estimation

| Beef disappearance (Thousand tonnes) Quarter | Quantity | Quarter | Quantity | Quarter | Quantity |
|---|---|---|---|---|---|
| 1976-1 | 282.142 | 1984-4 | 235.142 | 1993-3 | 236.715 |
| 1976-2 | 292.193 | 1985-1 | 232.181 | 1993-4 | 216.480 |
| 1976-3 | 303.575 | 1985-2 | 252.920 | 1994-1 | 251.014 |
| 1976-4 | 299.585 | 1985-3 | 272.389 | 1994-2 | 241.780 |
| 1977-1 | 285.978 | 1985-4 | 234.679 | 1994-3 | 245.060 |
| 1977-2 | 294.560 | 1986-1 | 231.021 | 1994-4 | 254.449 |
| 1977-3 | 299.523 | 1986-2 | 260.299 | 1995-1 | 242.347 |
| 1977-4 | 278.332 | 1986-3 | 264.934 | 1995-2 | 243.933 |
| 1978-1 | 278.589 | 1986-4 | 240.534 | 1995-3 | 254.569 |
| 1978-2 | 263.745 | 1987-1 | 244.108 | 1995-4 | 233.711 |
| 1978-3 | 281.917 | 1987-2 | 245.253 | 1996-1 | 249.577 |
| 1978-4 | 267.331 | 1987-3 | 259.059 | 1996-2 | 286.806 |
| 1979-1 | 237.292 | 1987-4 | 231.109 | 1996-3 | 265.580 |
| 1979-2 | 243.260 | 1988-1 | 247.817 | 1996-4 | 252.248 |
| 1979-3 | 246.716 | 1988-2 | 260.153 | 1997-1 | 241.484 |
| 1979-4 | 233.788 | 1988-3 | 253.107 | 1997-2 | 258.849 |
| 1980-1 | 224.627 | 1988-4 | 231.905 | 1997-3 | 251.417 |
| 1980-2 | 253.228 | 1989-1 | 225.838 | 1997-4 | 232.503 |
| 1980-3 | 249.074 | 1989-2 | 262.885 | 1998-1 | 260.917 |
| 1980-4 | 237.975 | 1989-3 | 257.218 | 1998-2 | 261.986 |
| 1981-1 | 243.425 | 1989-4 | 232.812 | 1998-3 | 244.440 |
| 1981-2 | 257.643 | 1990-1 | 249.486 | 1998-4 | 250.371 |
| 1981-3 | 256.724 | 1990-2 | 271.729 | 1999-1 | 278.251 |
| 1981-4 | 251.314 | 1990-3 | 248.299 | 1999-2 | 277.782 |
| 1982-1 | 239.232 | 1990-4 | 218.919 | 1999-3 | 274.947 |
| 1982-2 | 244.955 | 1991-1 | 235.939 | 1999-4 | 251.076 |
| 1982-3 | 261.201 | 1991-2 | 251.966 | 2000-1 | 219.780 |
| 1982-4 | 262.609 | 1991-3 | 236.253 | 2000-2 | 240.793 |
| 1983-1 | 239.230 | 1991-4 | 229.143 | 2000-3 | 229.430 |
| 1983-2 | 257.988 | 1992-1 | 230.656 | 2000-4 | 198.204 |
| 1983-3 | 262.875 | 1992-2 | 250.864 | 2001-1 | 209.735 |
| 1983-4 | 249.488 | 1992-3 | 242.645 | 2001-2 | 256.675 |
| 1984-1 | 231.737 | 1992-4 | 238.016 | 2001-3 | 221.702 |
| 1984-2 | 250.617 | 1993-1 | 239.286 | 2001-4 | 249.848 |
| 1984-3 | 256.502 | 1993-2 | 303.516 | | |

Source: Elaborated with information from Statistics Canada and Agriculture and Agri-Food Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources.

Pork Disappearance Data Used for the Time Series Estimation

| Pork disappearance (Thousand tonnes) | | | | | |
|---|---|---|---|---|---|
| Quarter | Quantity | Quarter | Quantity | Quarter | Quantity |
| 1976-1 | 139.399 | 1984-4 | 204.091 | 1993-3 | 230.550 |
| 1976-2 | 143.561 | 1985-1 | 202.199 | 1993-4 | 219.183 |
| 1976-3 | 145.530 | 1985-2 | 204.726 | 1994-1 | 202.855 |
| 1976-4 | 177.050 | 1985-3 | 201.787 | 1994-2 | 197.276 |
| 1977-1 | 164.729 | 1985-4 | 204.869 | 1994-3 | 206.528 |
| 1977-2 | 156.135 | 1986-1 | 205.396 | 1994-4 | 217.276 |
| 1977-3 | 156.617 | 1986-2 | 197.190 | 1995-1 | 248.392 |
| 1977-4 | 168.571 | 1986-3 | 185.800 | 1995-2 | 233.206 |
| 1978-1 | 166.645 | 1986-4 | 209.389 | 1995-3 | 230.539 |
| 1978-2 | 162.334 | 1987-1 | 210.781 | 1995-4 | 225.396 |
| 1978-3 | 168.763 | 1987-2 | 187.913 | 1996-1 | 223.953 |
| 1978-4 | 175.233 | 1987-3 | 198.659 | 1996-2 | 198.104 |
| 1979-1 | 181.174 | 1987-4 | 205.563 | 1996-3 | 200.518 |
| 1979-2 | 191.360 | 1988-1 | 212.361 | 1996-4 | 197.782 |
| 1979-3 | 192.384 | 1988-2 | 193.123 | 1997-1 | 197.793 |
| 1979-4 | 209.592 | 1988-3 | 210.580 | 1997-2 | 186.338 |
| 1980-1 | 215.592 | 1988-4 | 215.324 | 1997-3 | 193.026 |
| 1980-2 | 218.556 | 1989-1 | 221.081 | 1997-4 | 197.305 |
| 1980-3 | 198.888 | 1989-2 | 214.673 | 1998-1 | 251.850 |
| 1980-4 | 211.183 | 1989-3 | 212.812 | 1998-2 | 214.999 |
| 1981-1 | 215.975 | 1989-4 | 215.190 | 1998-3 | 246.525 |
| 1981-2 | 206.368 | 1990-1 | 216.950 | 1998-4 | 267.644 |
| 1981-3 | 194.108 | 1990-2 | 197.705 | 1999-1 | 248.957 |
| 1981-4 | 213.839 | 1990-3 | 183.239 | 1999-2 | 240.885 |
| 1982-1 | 207.419 | 1990-4 | 203.401 | 1999-3 | 291.540 |
| 1982-2 | 190.022 | 1991-1 | 213.125 | 1999-4 | 274.244 |
| 1982-3 | 172.736 | 1991-2 | 196.345 | 2000-1 | 234.407 |
| 1982-4 | 205.543 | 1991-3 | 195.936 | 2000-2 | 225.108 |
| 1983-1 | 197.037 | 1991-4 | 217.338 | 2000-3 | 223.831 |
| 1983-2 | 195.888 | 1992-1 | 228.508 | 2000-4 | 228.528 |
| 1983-3 | 199.344 | 1992-2 | 211.683 | 2001-1 | 229.226 |
| 1983-4 | 214.749 | 1992-3 | 222.250 | 2001-2 | 220.625 |
| 1984-1 | 203.362 | 1992-4 | 241.080 | 2001-3 | 227.434 |
| 1984-2 | 193.231 | 1993-1 | 236.511 | 2001-4 | 272.847 |
| 1984-3 | 188.503 | 1993-2 | 206.485 | | |

Source: Elaborated with information from Statistics Canada and Agriculture and Agri-Food Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources.

Chicken Disappearance Data Used for the Time Series Estimation

| Chicken disappearance (Thousand tonnes) | | | | | |
|---|---|---|---|---|---|
| Quarter | Quantity | Quarter | Quantity | Quarter | Quantity |
| 1976-1 | 74.380 | 1984-4 | 109.061 | 1993-3 | 173.644 |
| 1976-2 | 81.798 | 1985-1 | 118.694 | 1993-4 | 177.320 |
| 1976-3 | 85.327 | 1985-2 | 125.076 | 1994-1 | 162.697 |
| 1976-4 | 80.065 | 1985-3 | 124.569 | 1994-2 | 198.886 |
| 1977-1 | 80.805 | 1985-4 | 116.425 | 1994-3 | 196.340 |
| 1977-2 | 87.089 | 1986-1 | 121.052 | 1994-4 | 213.854 |
| 1977-3 | 88.663 | 1986-2 | 131.628 | 1995-1 | 166.575 |
| 1977-4 | 82.292 | 1986-3 | 128.322 | 1995-2 | 186.554 |
| 1978-1 | 83.658 | 1986-4 | 123.065 | 1995-3 | 192.264 |
| 1978-2 | 93.455 | 1987-1 | 130.070 | 1995-4 | 172.373 |
| 1978-3 | 92.651 | 1987-2 | 138.679 | 1996-1 | 181.541 |
| 1978-4 | 91.698 | 1987-3 | 143.474 | 1996-2 | 189.255 |
| 1979-1 | 96.687 | 1987-4 | 130.167 | 1996-3 | 190.827 |
| 1979-2 | 100.472 | 1988-1 | 139.551 | 1996-4 | 189.328 |
| 1979-3 | 104.611 | 1988-2 | 148.035 | 1997-1 | 184.761 |
| 1979-4 | 95.581 | 1988-3 | 144.032 | 1997-2 | 203.573 |
| 1980-1 | 96.672 | 1988-4 | 138.212 | 1997-3 | 198.831 |
| 1980-2 | 106.362 | 1989-1 | 136.654 | 1997-4 | 199.407 |
| 1980-3 | 99.897 | 1989-2 | 148.539 | 1998-1 | 198.928 |
| 1980-4 | 91.195 | 1989-3 | 147.278 | 1998-2 | 204.133 |
| 1981-1 | 96.794 | 1989-4 | 136.586 | 1998-3 | 204.754 |
| 1981-2 | 103.723 | 1990-1 | 142.738 | 1998-4 | 214.942 |
| 1981-3 | 102.128 | 1990-2 | 159.380 | 1999-1 | 211.839 |
| 1981-4 | 91.074 | 1990-3 | 154.005 | 1999-2 | 214.299 |
| 1982-1 | 97.326 | 1990-4 | 149.803 | 1999-3 | 214.408 |
| 1982-2 | 105.637 | 1991-1 | 145.100 | 1999-4 | 208.586 |
| 1982-3 | 104.015 | 1991-2 | 159.730 | 2000-1 | 215.961 |
| 1982-4 | 96.745 | 1991-3 | 156.782 | 2000-2 | 233.334 |
| 1983-1 | 102.223 | 1991-4 | 151.925 | 2000-3 | 242.935 |
| 1983-2 | 109.081 | 1992-1 | 147.523 | 2000-4 | 213.340 |
| 1983-3 | 103.952 | 1992-2 | 163.736 | 2001-1 | 230.752 |
| 1983-4 | 95.919 | 1992-3 | 164.503 | 2001-2 | 242.141 |
| 1984-1 | 109.626 | 1992-4 | 164.269 | 2001-3 | 241.690 |
| 1984-2 | 115.242 | 1993-1 | 152.076 | 2001-4 | 242.670 |
| 1984-3 | 114.467 | 1993-2 | 171.627 | | |

Source: Elaborated with information from Statistics Canada and Agriculture and Agri-Food Canada, using various issues of the Livestock and Meat Trade Report, as well as non-public data sources.

# Appendix C

Nonlinear multiple regression estimates of the parameters of the expenditure share GBC system for meat consumption in Canada, 1978 - 2001

| | Parameter | Estimate | t-statistic |
|---|---|---|---|
| Common parameters | Lamda | 0.375757 *** | 3.9335 |
| | Price BB | 0.594607 *** | 5.53662 |
| | Price BP | -0.134131 ** | -2.10216 |
| | Price BC | -0.092571 *** | -2.8956 |
| | Price PP | -0.470685 *** | -8.03523 |
| | Price PC | -0.116843 *** | -4.631 |
| | Price CC | -1.12E-01 *** | -4.89657 |
| Beef share equation | Intercept | -0.579188 *** | -35.2216 |
| | Q1 | -0.025067 *** | -3.74436 |
| | Q2 | -0.023766 *** | -2.69255 |
| | Q3 | 2.37E-03 | 0.351625 |
| | Time | 0.465803 *** | 7.02302 |
| | Beef gen. adv. | -0.047487 *** | -3.60179 |
| | Pork gen. adv. | -0.042917 ** | -2.41737 |
| | Chicken gen. adv. | -0.010071 | -0.680003 |
| | Beef brand adv. | -0.04671 *** | -4.34159 |
| | Pork brand adv. | -6.76E-03 | -0.558279 |
| | Chicken brand adv. | -3.19E-03 | -1.43783 |
| | Beef rest. Adv. | -0.08336 ** | -2.12618 |
| | Chicken rest. Adv. | -0.030942 *** | -3.528 |
| | Beef food safety | -9.34E-03 * | -1.6751 |
| | Pork food safety | 6.48E-03 | 0.489207 |
| | Chicken food safety | -0.053745 ** | -2.23004 |
| | Beef health | 2.20E-02 | 0.211054 |
| | Pork health | -0.095101 | -1.02503 |
| | Chicken health | 0.083119 | 0.681683 |
| Pork share equation | Intercept | -0.268259 *** | -17.9546 |
| | Q1 | -2.18E-03 | -0.392821 |
| | Q2 | -3.83E-03 | -0.575958 |
| | Q3 | 2.92E-03 | 0.442382 |
| | Time | 0.201312 *** | 5.69919 |
| | Beef gen. adv. | -0.028886 *** | -3.11954 |
| | Pork gen. adv. | -0.037616 *** | -3.67945 |
| | Chicken gen. adv. | 8.46E-03 | 0.86564 |
| | Beef brand adv. | -0.026222 *** | -4.234 |
| | Pork brand adv. | -6.08E-03 | -0.775997 |
| | Chicken brand adv. | -1.97E-03 | -1.31799 |
| | Beef food safety | -2.35E-03 | -0.649806 |
| | Pork food safety | 3.40E-03 | 0.408176 |
| | Chicken food safety | -3.33E-02 ** | -2.02247 |
| | Beef health | 0.033293 | 0.436749 |
| | Pork health | -0.112456 * | -1.95205 |
| | Chicken health | -3.96E-02 | -0.481893 |
| Chicken share equation | Q1 | -1.90E-03 | -0.796191 |
| | Q2 | -8.83E-03 *** | -2.55464 |
| | Q3 | -2.80E-03 | -1.021 |
| | Time | 0.081819 *** | 4.12492 |
| | Beef gen. adv. | -0.010254 ** | -2.34499 |
| | Pork gen. adv. | -0.01427 ** | -2.47013 |
| | Chicken gen. adv. | -3.94E-03 | -0.61714 |
| | Beef brand adv. | -1.40E-02 *** | -4.86786 |
| | Pork brand adv. | -9.08E-03 ** | -2.12367 |
| | Chicken brand adv. | -1.17E-03 | -1.49864 |
| | Beef rest. Adv. | -5.38E-02 *** | -3.88306 |
| | Chicken rest. Adv. | -5.71E-04 | -0.276413 |
| | Beef food safety | -4.52E-03 ** | -2.14059 |
| | Pork food safety | 5.29E-03 | 1.08892 |
| | Chicken food safety | -1.79E-02 | -1.9411 |
| | Beef health | -1.75E-02 | -0.455151 |
| | Pork health | -0.094551 ** | -2.2106 |
| | Chicken health | 0.040036 | 0.736794 |
| | Beef | Pork | |
| D.W | 1.056 | 1.008 | |
| L.M. Heteroskedasticity test | 0.683 | 3.718 | |
| $R^2$ | 0.599 | 0.14 | |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.

# Appendix D

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 1996 Food Expenditure Survey

| | Parameter | Estimate | | t-statistic |
|---|---|---|---|---|
| **Common parameters** | Price BH BH | -0.129735 | *** | -13.0349 |
| | Price BH BL | 0.024256 | *** | 3.26911 |
| | Price BH PH | 0.03673 | *** | 5.23439 |
| | Price BH PL | 0.017622 | *** | 4.25648 |
| | Price BH P | 0.032173 | *** | 5.72808 |
| | Price BL BL | -0.083342 | *** | -8.18246 |
| | Price BL PH | 0.015108 | ** | 2.21408 |
| | Price BL PL | 9.49E-03 | *** | 2.63603 |
| | Price BL P | 0.024185 | *** | 3.8588 |
| | Price PH PH | -0.089644 | *** | -9.98931 |
| | Price PH PL | 8.93E-03 | ** | 2.19711 |
| | Price PH P | 0.017057 | *** | 3.36947 |
| | Price PL PL | -0.037232 | *** | -6.56845 |
| | Price PL P | -3.50E-03 | | -1.47546 |
| | Price P P | -0.069996 | *** | -9.27348 |
| **Beef high value share equation** | Intercept | 1.4819 | * | 1.80681 |
| | Q1 | -0.16133 | | -1.12625 |
| | Q2 | 3.38E-03 | | 0.07288 |
| | Q3 | 0.013243 | | 0.686265 |
| | Atlantic | -6.98E-05 | | -1.73E-03 |
| | Quebec | 0.027822 | | 0.87423 |
| | Ontario | 0.079315 | | 1.43383 |
| | Prairies | 0.039364 | | 0.988514 |
| | Big urban | 0.01828 | *** | 2.42313 |
| | Small urban | 2.56E-03 | | 0.304403 |
| | Married | 2.40E-03 | | 0.272804 |
| | Age | -4.31E-05 | | -0.135251 |
| | Sex | -0.029102 | *** | -4.73844 |
| | Household size | -0.023852 | *** | -5.39712 |
| | Seniors | -6.86E-04 | | -0.052729 |
| | Adults | -6.95E-03 | | -0.591798 |
| | Youth | 4.69E-03 | | 0.554207 |
| | Children | -6.50E-04 | | -0.0621 |
| | Economic families | 0.015343 | | 0.8743 |
| | Income | 7.39E-05 | *** | 7.05128 |
| | FAFH | 6.94E-05 | * | 1.86711 |
| | Beef food safety | -0.274732 | | -1.58318 |
| | Pork food safety | 0.03084 | | 0.820655 |
| | Chicken food safety | 0.019156 | | 0.713078 |
| | Beef health | -2.19E-03 | | -0.593546 |
| | Pork health | 3.72E-03 | | 0.416175 |
| | Chicken health | 1.85E-03 | | 0.286192 |

Note: ****, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 1996 Food Expenditure Survey (continues…)

| | Parameter | Estimate | | t-statistic |
|---|---|---|---|---|
| **Beef low value share equation** | Intercept | -0.446762 | | -0.463693 |
| | Q1 | 0.055759 | | 0.331309 |
| | Q2 | -0.013315 | | -0.244264 |
| | Q3 | 0.047109 | ** | 2.0774 |
| | Atlantic | 0.016759 | | 0.352755 |
| | Quebec | 0.025099 | | 0.671274 |
| | Ontario | -0.048843 | | -0.751598 |
| | Prairies | 8.86E-03 | | 0.18942 |
| | Big urban | -7.23E-03 | | -0.757104 |
| | Small urban | 0.013824 | | 1.04713 |
| | Married | -0.013432 | | -1.23392 |
| | Single | -0.02862 | ** | -2.05826 |
| | Age | -7.23E-04 | * | -1.88052 |
| | Sex | 6.01E-03 | | 0.828834 |
| | Household size | 0.02112 | *** | 4.06932 |
| | Seniors | -0.021474 | | -1.40397 |
| | Adults | -0.025683 | * | -1.8608 |
| | Youth | 0.017718 | * | 1.78147 |
| | Children | -2.28E-03 | | -0.184047 |
| | Economic families | -3.69E-03 | | -0.177981 |
| | Income | -7.91E-05 | *** | -6.40844 |
| | FAFH | -9.43E-05 | ** | -2.16039 |
| | Beef food safety | 0.177784 | | 0.872058 |
| | Pork food safety | -0.074329 | * | -1.68355 |
| | Chicken food safety | 0.018748 | | 0.593985 |
| | Beef health | 4.00E-03 | | 0.922211 |
| | Pork health | 0.010638 | | 1.012 |
| | Chicken health | -0.012597 | * | -1.6598 |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 1996 Food Expenditure Survey (continues...)

| | Parameter | Estimate | t-statistic |
|---|---|---|---|
| **Pork high value share equation** | Intercept | -1.2674 * | -1.7469 |
| | Q1 | 0.237814 * | 1.87678 |
| | Q2 | 0.065048 | 1.58491 |
| | Q3 | 0.02909 * | 1.70508 |
| | Atlantic | 0.029976 | 0.837881 |
| | Quebec | -8.58E-03 | -0.304865 |
| | Ontario | -0.087839 * | -1.79512 |
| | Prairies | -0.045828 | -1.30107 |
| | Big urban | -0.025738 *** | -3.56476 |
| | Small urban | -5.73E-03 | -0.570067 |
| | Married | 0.020048 *** | 2.439 |
| | Single | 3.77E-03 | 0.355214 |
| | Age | 6.32E-04 ** | 2.18177 |
| | Sex | 3.67E-03 | 0.672326 |
| | Household size | -4.75E-03 | -1.21592 |
| | Seniors | 9.15E-03 | 0.794659 |
| | Adults | 9.92E-03 | 0.95422 |
| | Youth | -0.010611 | -1.41656 |
| | Children | 4.31E-03 | 0.4628 |
| | Economic families | 3.21E-03 | 0.205668 |
| | Income | -5.47E-06 | -0.591865 |
| | FAFH | 4.73E-05 | 1.43896 |
| | Beef food safety | 0.286222 * | 1.86445 |
| | Pork food safety | -0.012634 | -0.379988 |
| | Chicken food safety | -0.020894 | -0.878782 |
| | Beef health | -3.14E-03 | -0.960865 |
| | Pork health | -6.21E-03 | -0.784427 |
| | Chicken health | 7.33E-03 | 1.28268 |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 1996 Food Expenditure Survey (continues...)

| | Parameter | Estimate | | t-statistic |
|---|---|---|---|---|
| **Pork low value share equation** | Intercept | -0.140703 | | -0.442555 |
| | Q1 | 0.036574 | | 0.658812 |
| | Q2 | 5.31E-03 | | 0.295426 |
| | Q3 | -6.49E-03 | | -0.867828 |
| | Atlantic | -8.24E-03 | | -0.525956 |
| | Quebec | -0.01172 | | -0.950407 |
| | Ontario | -0.015029 | | -0.701103 |
| | Prairies | -0.012214 | | -0.791482 |
| | Big urban | -8.22E-03 | *** | -2.5927 |
| | Small urban | -0.010638 | *** | -2.39945 |
| | Married | 4.21E-03 | | 1.16707 |
| | Single | 1.34E-05 | | 2.87E-03 |
| | Age | 3.28E-04 | *** | 2.57922 |
| | Sex | -2.11E-03 | | -0.883856 |
| | Household size | 1.29E-03 | | 0.752538 |
| | Seniors | -6.82E-03 | | -1.3512 |
| | Adults | 4.21E-03 | | 0.924227 |
| | Youth | 4.36E-04 | | 0.13292 |
| | Children | -2.12E-03 | | -0.519607 |
| | Economic families | -2.63E-03 | | -0.385296 |
| | Income | -2.02E-05 | *** | -4.9947 |
| | FAFH | -9.76E-07 | | -0.067705 |
| | Beef food safety | 0.029397 | | 0.437051 |
| | Pork food safety | 0.010649 | | 0.731227 |
| | Chicken food safety | -2.60E-03 | | -0.249837 |
| | Beef health | 7.73E-04 | | 0.540129 |
| | Pork health | -3.10E-03 | | -0.893586 |
| | Chicken health | -1.40E-03 | | -0.557386 |

Note: *** indicate significance at the 1 percent level.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 1996 Food Expenditure Survey (continues...)

| | Parameter | Estimate | t-statistic |
|---|---|---|---|
| **Poultry share equation** | Intercept | 1.46469 | 1.43336 |
| | Q1 | -0.239774 | -1.34332 |
| | Q2 | -0.096778 * | -1.67364 |
| | Q3 | -0.077019 *** | -3.2053 |
| | Atlantic | -0.042031 | -0.833798 |
| | Quebec | -0.067785 *** | -1.70903 |
| | Ontario | 0.07425 | 1.07712 |
| | Prairies | 0.03619 | 0.729249 |
| | Big urban | 7.69E-03 | 0.761636 |
| | Small urban | -1.48E-03 | -0.106653 |
| | Married | -0.014241 | -1.23591 |
| | Single | 0.014591 | 1.00023 |
| | Age | -1.08E-03 *** | -2.65494 |
| | Sex | 0.018986 *** | 2.46928 |
| | Household size | 7.00E-03 | 1.27072 |
| | Seniors | 0.019914 | 1.22699 |
| | Adults | 0.012588 | 0.859622 |
| | Youth | -0.012567 | -1.19079 |
| | Children | -5.88E-03 | -0.447865 |
| | Economic families | -0.010094 | -0.459449 |
| | Income | 2.74E-05 ** | 2.10477 |
| | FAFH | -1.93E-05 | -0.417211 |
| | Beef food safety | -0.217538 | -1.00616 |
| | Pork food safety | 0.010341 | 0.220737 |
| | Chicken food safety | -5.08E-03 | -0.151579 |
| | Beef health | 1.21E-03 | 0.262525 |
| | Pork health | 1.44E-03 | 0.128696 |
| | Chicken health | -2.38E-03 | -0.295298 |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 2001 Food Expenditure Survey

| | Parameter | Estimate | | t-statistic |
|---|---|---|---|---|
| **Common parameters** | Price BH BH | -0.083102 | *** | -6.32258 |
| | Price BH BL | 5.27E-03 | | 0.510076 |
| | Price BH PH | 0.022457 | ** | 2.3607 |
| | Price BH PL | 0.015967 | *** | 3.40424 |
| | Price BH P | 0.024488 | *** | 3.2105 |
| | Price BL BL | -0.087238 | *** | -6.02059 |
| | Price BL PH | 0.034736 | *** | 3.44209 |
| | Price BL PL | 9.52E-03 | ** | 1.95548 |
| | Price BL P | 0.03035 | *** | 3.67195 |
| | Price PH PH | -0.114246 | *** | -8.90397 |
| | Price PH PL | 0.0157 | *** | 3.06202 |
| | Price PH P | 0.026137 | *** | 3.78104 |
| | Price PL PL | -0.049534 | *** | -6.74376 |
| | Price PL P | 9.84E-04 | | 0.357327 |
| | Price P P | -0.07878 | *** | -7.66156 |
| **Beef high value share equation** | Intercept | 1.50721 | | 0.557319 |
| | Q1 | -0.064095 | | -0.178255 |
| | Q2 | -0.088912 | | -0.406747 |
| | Q3 | -0.02242 | | -0.170237 |
| | Atlantic | -0.015297 | | -0.769528 |
| | Quebec | 0.058948 | | 1.4432 |
| | Ontario | 0.053573 | | 0.665217 |
| | Prairies | 0.053734 | | 0.895582 |
| | Big urban | -5.44E-03 | | -0.489288 |
| | Small urban | 4.14E-03 | | 0.352053 |
| | Married | -5.53E-03 | | -0.427389 |
| | Age | 6.18E-05 | | 0.136426 |
| | Sex | -1.52E-03 | | -0.172644 |
| | Household size | -0.01543 | ** | -2.3491 |
| | Seniors | -1.92E-03 | | -0.107997 |
| | Adults | -0.017668 | | -1.03495 |
| | Youth | -1.25E-03 | | -0.100079 |
| | Children | 3.20E-03 | | 0.210911 |
| | Economic families | -1.91E-03 | | -0.073445 |
| | Low income | 0.021632 | * | 1.8279 |
| | Middle income | 0.032826 | ** | 2.44194 |
| | High income | 0.034938 | ** | 1.94074 |
| | FAFH | 5.75E-05 | | 1.33624 |
| | Beef food safety | -0.232606 | | -0.452515 |
| | Pork food safety | 0.096584 | | 1.07801 |
| | Chicken food safety | -0.044167 | | -0.606012 |
| | Beef health | 7.99E-04 | | 0.246944 |
| | Pork health | -9.38E-04 | | -0.138834 |
| | Chicken health | -1.33E-03 | | -0.116492 |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 2001 Food Expenditure Survey (continues...)

| | Parameter | Estimate | t-statistic |
|---|---|---|---|
| **Beef low value share equation** | Intercept | 3.65452 | 1.24008 |
| | Q1 | -0.176609 | -0.450857 |
| | Q2 | -0.22198 | -0.932075 |
| | Q3 | -0.179925 | -1.25375 |
| | Atlantic | 0.04731 ** | 2.18268 |
| | Quebec | 0.085888 * | 1.92975 |
| | Ontario | -0.0417 | -0.475132 |
| | Prairies | 0.100882 | 1.54299 |
| | Big urban | -0.023165 * | -1.76015 |
| | Small urban | 8.00E-03 | 0.462509 |
| | Married | 2.82E-03 | 0.190509 |
| | Single | 0.016696 | 0.902617 |
| | Age | 3.19E-04 | 0.629685 |
| | Sex | -3.34E-03 | -0.346616 |
| | Household size | 0.022175 *** | 3.09904 |
| | Seniors | -0.038452 ** | -1.98039 |
| | Adults | -3.65E-04 | -0.019617 |
| | Youth | -6.16E-03 | -0.453272 |
| | Children | 5.96E-03 | 0.358533 |
| | Economic families | 0.015287 | 0.538777 |
| | Low income | -0.021897 * | -1.69832 |
| | Middle income | -0.058504 *** | -3.99101 |
| | High income | -0.070322 *** | -3.57157 |
| | FAFH | -6.82E-05 | -1.45436 |
| | Beef food safety | -0.658861 | -1.17621 |
| | Pork food safety | 0.035034 | 0.35887 |
| | Chicken food safety | 0.105818 | 1.33219 |
| | Beef health | 4.56E-03 | 1.29242 |
| | Pork health | -5.67E-03 | -0.770484 |
| | Chicken health | 3.22E-03 | 0.258046 |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 2001 Food Expenditure Survey (continues...)

| | Parameter | Estimate | t-statistic |
|---|---|---|---|
| **Pork high value share equation** | Intercept | -2.18306 | -0.91575 |
| | Q1 | 0.01478 | 0.046649 |
| | Q2 | 0.106761 | 0.554207 |
| | Q3 | 0.126664 | 1.09108 |
| | Atlantic | 7.54E-03 | 0.430544 |
| | Quebec | -0.083873 ** | -2.33013 |
| | Ontario | 0.073877 | 1.04146 |
| | Prairies | -0.03367 | -0.636671 |
| | Big urban | 2.50E-03 | 0.234052 |
| | Small urban | 0.022997 * | 1.63411 |
| | Married | 0.033142 *** | 2.76441 |
| | Single | -0.014293 | -0.948293 |
| | Age | 4.45E-04 | 1.08535 |
| | Sex | -0.010195 | -1.30931 |
| | Household size | -0.011126 ** | -1.92204 |
| | Seniors | 6.72E-03 | 0.427799 |
| | Adults | 3.68E-03 | 0.244788 |
| | Youth | -0.012951 | -1.1788 |
| | Children | 8.17E-03 | 0.607937 |
| | Economic families | 0.058384 *** | 2.54357 |
| | Low income | -0.01378 | -1.32296 |
| | Middle income | -0.016619 | -1.40549 |
| | High income | 0.013819 | 0.880957 |
| | FAFH | -2.67E-05 | -0.702658 |
| | Beef food safety | 0.454719 | 1.00354 |
| | Pork food safety | -9.62E-03 | -0.121862 |
| | Chicken food safety | -0.076572 | -1.19214 |
| | Beef health | -4.10E-03 | -1.43858 |
| | Pork health | 7.79E-03 | 1.30856 |
| | Chicken health | -5.79E-03 | -0.573614 |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 2001 Food Expenditure Survey (continues...)

| | Parameter | Estimate | t-statistic |
|---|---|---|---|
| **Pork low value share equation** | Intercept | -0.457268 | -0.512738 |
| | Q1 | -0.097673 | -0.824054 |
| | Q2 | -0.033009 | -0.458052 |
| | Q3 | 0.016167 | 0.372267 |
| | Atlantic | -0.016532 *** | -2.5227 |
| | Quebec | -0.014355 | -1.06594 |
| | Ontario | 6.57E-03 | 0.247412 |
| | Prairies | -0.013036 | -0.658934 |
| | Big urban | -6.53E-03 * | -1.62907 |
| | Small urban | -7.03E-03 | -1.32364 |
| | Married | 3.45E-03 | 0.76663 |
| | Single | 3.50E-04 | 0.061384 |
| | Age | 1.93E-04 | 1.25897 |
| | Sex | -2.15E-03 | -0.738252 |
| | Household size | 2.45E-04 | 0.113055 |
| | Seniors | 7.24E-03 | 1.23175 |
| | Adults | 6.27E-03 | 1.11338 |
| | Youth | 1.74E-03 | 0.424137 |
| | Children | 2.27E-03 | 0.452286 |
| | Economic families | 3.53E-03 | 0.411657 |
| | Low income | -0.014086 *** | -3.61277 |
| | Middle income | -0.016656 *** | -3.75726 |
| | High income | -9.65E-03 * | -1.64206 |
| | FAFH | -2.17E-05 | -1.52849 |
| | Beef food safety | 0.130501 | 0.769913 |
| | Pork food safety | -0.033355 | -1.12907 |
| | Chicken food safety | -0.03497 | -1.45541 |
| | Beef health | 1.31E-03 | 1.22503 |
| | Pork health | 1.60E-03 | 0.71815 |
| | Chicken health | -3.98E-03 | -1.05346 |

Note: *** and * indicate significance at the 1 and 10 percent level, respectively.

Multiple regression estimates of the parameters of the expenditure share AIDS system for meat consumption in Canada, 2001 Food Expenditure Survey (continues...)

| | Parameter | Estimate | | t-statistic |
|---|---|---|---|---|
| **Poultry share equation** | Intercept | -1.86455 | | -0.553641 |
| | Q1 | 0.568171 | | 1.26931 |
| | Q2 | 0.364861 | | 1.34065 |
| | Q3 | 0.076945 | | 0.469164 |
| | Atlantic | 3.61E-03 | | 0.14608 |
| | Quebec | -0.063159 | | -1.24223 |
| | Ontario | -0.121613 | | -1.21365 |
| | Prairies | -0.104459 | | -1.39816 |
| | Big urban | 0.015924 | | 1.06599 |
| | Small urban | -0.033102 | * | -1.70872 |
| | Married | -0.035016 | ** | -2.07943 |
| | Single | -2.57E-03 | | -0.124551 |
| | Age | -1.50E-03 | *** | -2.60026 |
| | Sex | 0.018338 | * | 1.66806 |
| | Household size | 7.70E-03 | | 0.941165 |
| | Seniors | 0.019682 | | 0.886991 |
| | Adults | 1.77E-03 | | 0.083295 |
| | Youth | 0.023748 | | 1.53032 |
| | Children | -0.023571 | | -1.24246 |
| | Economic families | -0.074793 | ** | -2.30704 |
| | Low income | 0.031133 | ** | 2.11606 |
| | Middle income | 0.047591 | *** | 2.84908 |
| | High income | 0.024543 | | 1.10905 |
| | FAFH | 2.94E-05 | | 0.547436 |
| | Beef food safety | 0.292461 | | 0.456871 |
| | Pork food safety | -0.05701 | | -0.511059 |
| | Chicken food safety | 0.079021 | | 0.870975 |
| | Beef health | -3.89E-03 | | -0.965711 |
| | Pork health | -5.49E-03 | | -0.652889 |
| | Chicken health | 0.015546 | | 1.08958 |

Note: ***, ** and * indicate significance at the 1, 5 and 10 percent level, respectively.