UNIVERSITY OF ALBERTA

EFFECTS OF GENERIC ADVERTISING AND CHOLESTEROL INFORMATION ON CANADIAN MEAT CONSUMPTION

BY

KWAMENA KORAKO QUAGRAINIE ©

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THE UNDERSIGNED CERTIFY THAT THEY HAVE READ, AND RECOMMEND TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH FOR ACCEPTANCE, A THESIS ENTITLED "*EFFECTS OF ADVERTISING AND CHOLESTEROL INFORMATION ON CANADIAN MEAT CONSUMPTION*" IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF *MASTER OF SCIENCE* IN *AGRICULTURAL ECONOMICS*.

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ABSTRACT

Meat consumption in Canada has shown some appreciable changes since the mid-1970s. Per capita consumption of beef has declined, per capita consumption of pork has also declined slightly, but per capita consumption of chicken has increased substantially. Various studies on meat demand in Canada have postulated a shift in preferences of meat consumers from "red" meats to "white" meats. Meat producer groups have consequently increased the level of effort and funds put into generic advertising of meats, apparently as a response to concerns that there may have been a "structural change" in preferences and consumption patterns for meat products. Concerns and perceptions regarding levels of saturated fats and cholesterol in the diet have been suggested as possible explanations of changes in the pattern of consumption of meat. Nevertheless, previous studies of the impact of advertising on Canadian meat consumption have not included cholesterol information as a variable. Some results from those earlier studies were rather inconsistent and anomalous.

This thesis study attempts to account explicitly for information relating to health perceptions and concerns by using a cholesterol information index to assess one possible basis of structural change in meat consumption; concurrently it is an objective of the study to assess the significance of advertising publicity in affecting consumers' purchasing decisions. The linear versions of the Almost Ideal Demand System (LA/AIDS) and Rotterdam models are utilized in the study in which one focus is to assess different approaches to model the effect of advertising on consumption of meat.

The results suggest that previous that previous studies of the impact of advertising on meat consumption, which have focused only on advertising expenditures alone and did not consider cholesterol information, may have been mispecified. In contrast with previous studies, when advertising and cholesterol information are both included as explanatory variables of demand for meat, we find results that conform with the economic theory of

demand and *a priori* expectations regarding the influence of information on consumers' decisions. It is also found that advertising effects are sensitive to the method of incorporating advertising into the demand model; estimates also varied by meat type. Generally, however, the LA/AIDS model explains the data better than the Rotterdam model or single equation models of demand for meat. Using the LA/AIDS model, incorporating advertising as a modification of marginal utilities, where advertising acts as a deflator of the real prices, gives statistically significant results that are in accord with *a prior* expectations, a characteristic that is less evident when advertising effects are modelled only as a demand "shifter". With own-advertising expenditures modelled as price deflators, all own-price elasticities are significantly increased. Moreover, advertising of each meat type is found to have increased demand as well as decreased demand for competing commodities. These results suggest that generic advertising has been effective in affecting consumers' consumption of meat; that advertising has apparently been effective in expanding the ranges of end uses or satisfaction for these meats; and that omission of cholesterol information in previous studies analysing advertising responsiveness appears to be a mispecification.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Commodity promotion and advertising have been important components of the marketing strategy pursued by some groups of producers of Canadian agricultural commodities and by processors or distributors of both food and non-food items. Advertising can be of two forms, namely brand advertising and generic advertising. Some products are highly differentiable; often these are highly processed consumer-level products sold as brand specific items. Marketing of such items often involves intensive firm-level brand advertising. Advertising and promotion of such specific brands or labels, or advertising of attributes unique to a differentiated subgroup of items within a product category, is referred to as brand advertising. Other products, however, are less differentiated and these may be advertised through some type of cooperative effort among producers and suppliers. Advertising and promotion for general or generic product groups is known as generic advertising (Forker and Ward 1993). The aim of both forms of advertising has been to cause a rightward shift in consumers' demand curve for the advertised commodity. It may also be an objective to "increase consumer loyalty" to achieve a more inelastic demand curve, at least for increases in price, for the good in question.

In Canada, meat producer groups have engaged in generic advertising of beef, pork, and chicken since the late 1960s. Some of the early advertising was done at the provincial levels. The Ontario Pork Producers' Association and the Alberta Chicken Marketing Agency, for example, began advertising in 1968 with printing of pamphlets, recipes, point-of-sale materials and some in-store demonstrations. Expenditure on advertising then was minimal. However from the mid-1970s, a greatly increased level of effort and funds has been put into generic advertising of meats, apparently as a response to concerns that there may have been a "structural change" in preferences and consumption patterns for major meat groups.

1.2 MEAT CONSUMPTION IN CANADA

Meat consumption in Canada has shown some appreciable changes since the mid-1970s. Per capita meat consumption in Canada from 1970.1 to 1993.4 is shown in Figure 1. Before the mid 1970s, beef consumption consistently increased until the sharp drop in the late 1970s; consumption per capita has trended downward since then. Pork consumption has also somewhat declined over time, at least over some subperiods, but the decline is not as dramatic as for beef. Pork consumption remained fairly constant over the time period from 1970 to 1980; consumption per capita trended downward slightly thereafter. Chicken consumption increased throughout the stated period. The beneficiary of the declining share of beef and pork consumption has been chicken.

Various studies on meat demand in Canada have reported a structural change in the demand for meat products implying there has been a shift in the preferences of meat consumers (see for example Atkins, Kerr and McGivern 1989; Chen and Veeman 1991; Reynolds and Goddard 1991). The change is believed to have taken place in the mid-1970s. While some of these studies model this as a somewhat abrupt shift in preferences in the mid-1970s, it appears that the shift has been more gradual. Reynolds and Goddard (1991) report a structural change starting from the first quarter of 1975 and subsiding in the first quarter of 1981. Own-price elasticity estimates presented by Reynolds and Goddard before and after the apparent structural change indicate that meat became less price elastic after the mid-1970s. In opposition to such conclusions Chalfant and Alston (1988) have suggested that the change in meat consumption has been the result of cyclical changes in price and income (Chalfant and Alston 1988). Subsequently Alston and Chalfant (1991) using a non-parametric approach to analyse Canadian meat demand, conclude that consumer preferences and consumption patterns for meats have been stable, but they indicate that the power of their test was "disappointingly low." Eales (1992) has also suggested that increasing preference for chicken over beef is probably due to the convenience of meat cuts and readiness for use of chicken as compared to beef. Although the conclusion is far from unanimous, a structural change in demand for meat products appears to have occurred in Canada.

1.3 HEALTH CONCERNS IN CANADA

Concern and perceptions regarding levels of saturated fats and cholesterol in the diet have been suggested as a major explanation of structural change in meat demand. There appears to be increasing concern about health risks of consuming large amounts of foods, including meats that are considered to be relatively high in cholesterol and saturated fats. In 1989 the National Institute of Nutrition (NIN) enlisted the support of industry and government to undertake a collaborative study to track baseline national nutrition trends related to attitudes and behaviours of Canadians regarding fat, fibre and cholesterol. In October 1989, a national randomly selected sample of 1980 adults was interviewed. Nutrition was "very" to "extremely" important to 59% of respondents. Concern for fat was highest and was expressed by 71% of respondents. Cholesterol was also a key concern (60%). Regarding sources of information, 70% of respondents cited radio and television and 65% magazines as the primary sources. This was followed by friends, relatives or colleagues (62%) and product labels (61%). Doctors and dietitians were the most trusted sources (Beggs et al. 1993).

Woolcott et al. (1983) studied the nutrition behaviour of a group of industrially employed males in southern Ontario. Many of these men reported changes in consumption of beef and pork for health reasons in the previous two to three years. Such health concerns may be a major influence on consumers' preferences and meat industry moves to trim visible fat from meat. Jones (1986) and Wood et al. (1988) refer to an unpublished survey which found that more than 70% of consumers reported trimming all visible fat from beef before consumption.

In the United States, a 1977 report to the United States Senate by a Select Committee on Nutrition and Human Needs outlined the results of its investigation into food consumption patterns and how these are related to the health of consumers. This report concludes that:

> "*...the increase in the proportion of fat and cholesterol in the diet was associated with disease patterns involving high rates of ischemic heart disease, certain forms of cancer, diabetes and obesity ... these diseases were the major causes of death and disability in the United States.*" (Hegsted 1977. p. 3).

Consumers are evidently concerned about healthy diets and appear to have adjusted their consumption patterns in accord with concerns and perceptions.

1.4 PROBLEM DEFINITION

It seems that health concerns by consumers affect their preferences for food. It is postulated that the necessary information from various sources by consumers on risks associated with high-cholesterol diets may have affected preferences for meat. To date, no study of Canadian meat consumption has attempted to account for health concerns other than by incorporating structural breaks in consumption and expenditure. This thesis study attempts to account explicitly for health perceptions and concerns in an attempt to explain the possible basis of structural change in meat consumption[1].

The beef and pork consumption patterns noted above, involving the decline in per capita consumption for beef and the lack of increase for pork, has been of concern to producer groups. Consequently, under the presumption that these reflect changes in consumers' preferences, beef and pork producer groups have increasingly funded generic advertising for their meat products in an attempt to counteract the negative trend in per capita consumption levels, and maintain or increase their current market share of the meat market. Generic advertising programs are funded by producers through levies on production. Beef advertising began in 1982, when per capita beef consumption appeared to have stagnated after falling from the mid-1970s. Since then, considerable effort has been directed at promotion of beef consumption at both the national and provincial levels. Administration of beef advertising programs has tended to be centralized; promotion programs are largely conducted through the Beef Information Centres. These are located at Toronto and Calgary and focus is on the eastern and western parts of Canada respectively.

Considerable effort has also been directed at pork promotion since the 1970s. In contrast to the situation for beef, pork advertising programs are somewhat decentralized in that much provincial advertising accompanies centralized efforts. At the national level, advertising is done through Canadian Pork Incorporated, a national agency for pork development. At the provincial level, in provinces with large hog sectors and particularly in Ontario, Quebec and Alberta, provincial producer groups also fund generic advertising. Advertising of poultry products has also occurred, particularly for chicken, but this has

[1] It has been found that concerns of consumers regarding cholesterol is a significant determinant of egg and meat consumption in the United States (Brown and Schrader 1990; Capps and Schmitz 1991). Although this concern is believed to be associated with fat content or perceptions of this, some researchers have concluded that, in the case of meats, increasing preference for chicken over beef is probably due to the convenience of meat cuts and readiness for use of chicken as compared to beef (Eales 1992).

involved relatively lower levels of expenditure than for other meats as is shown by the data depicted in Figure 2.

The benefits of producer funding of advertising campaigns for food items that tend to be universally consumed daily or very frequently, may be queried, as such selling efforts may be more effective if consumption levels have the potential for large increases or if consumers are unfamiliar with and consume relatively little of the product. Thus the necessity for generic advertisement of food commodities is not a priori evident. One of the objectives of this study is to assess empirically the effectiveness of generic advertising activity in stimulating consumption. Knowledge of the effectiveness of generic advertising relates to important policy issues for the various groups. Measures of the extent of this impact are necessary to quantify the return on investment in advertising, an important issue in terms of returns to producers. If the impact of advertising is known, optimal levels of advertising expenditure could be assessed (e.g Goddard and McCutcheon 1993). However, if generic advertising has relatively little effect on consumption, resources expended on it are likely better used elsewhere such as on research to improve productivity or reduce costs. The issue of quantifying the return on advertising investment and assessing optimal levels of advertisement activity are not examined in this study which focuses on estimating the effectiveness of the activity.

1.5 THESIS OBJECTIVE

The main objective of this study is to assess the significance of both advertising publicity and a measure of cholesterol concerns in affecting consumers' purchasing decisions. Price and income are economic factors that affect meat consumption; the possible influence of advertising publicity and information regarding cholesterol content of meats on consumers reactions to changes in prices and income levels is unknown since these commodities are considered as basic necessities in the normal human diets. In this study an attempt will be made to assess whether there is such an influence. Measures of consumer responsiveness to price changes will also be assessed. These objectives will be achieved by econometric analysis of aggregate data on demand using proxy measures relating to advertising and cholesterol/health concerns, as well as data series on prices and income. Since beef, pork and chicken are related products in consumption, advertising and pricing policies for these meat commodities are likely to affect the demand for each other and are considered simultaneously. One purpose of the study is to assess the extent of cross-commodity advertising and price influences of these commodities. This will be done by measuring the responsiveness of market shares to advertising and prices.

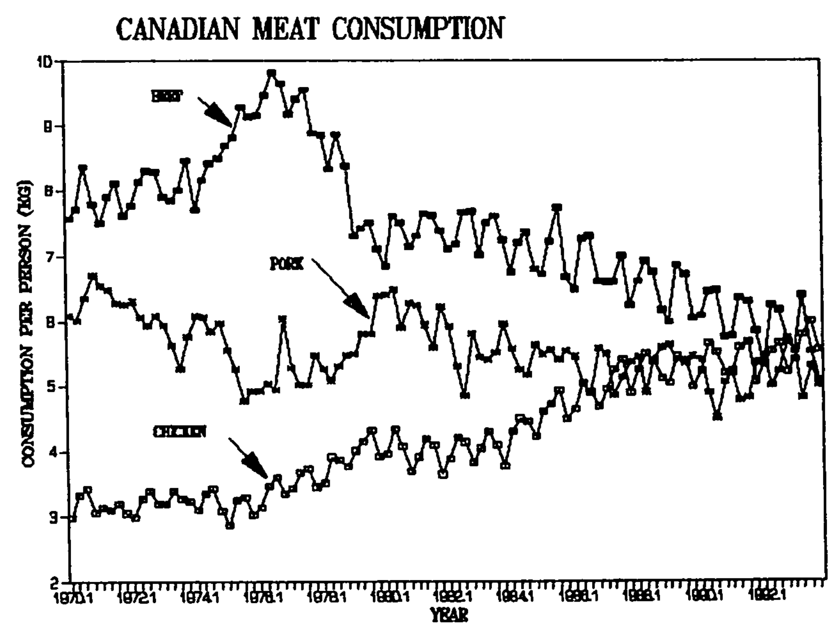
The economic theory of price and income on consumption of basic foods such as meat is well accepted without contention. This is not the case with advertising publicity and health concerns. The mechanism of assessing the effect of changes in prices of the good itself and the prices of related goods on demand responses is known; but accounting for the effect of advertising and health factors in the neoclassical context of the theory of demand, which is based on fixed tastes and preferences, is less clear. The study will utilize economic models to assess the response of consumption levels to interactions of demand, prices and competitive advertising.

Two flexible functional forms are estimated using a demand system approach, namely the linear versions of the Almost Ideal Demand System (AIDS) and the Rotterdam model, to test the null hypothesis that advertising publicity and cholesterol concerns have had no effects on consumption of beef, pork and chicken. The two models are used to investigate consistency in conclusions that may be made from results obtained from using different functional forms.

1.6 THESIS OUTLINE

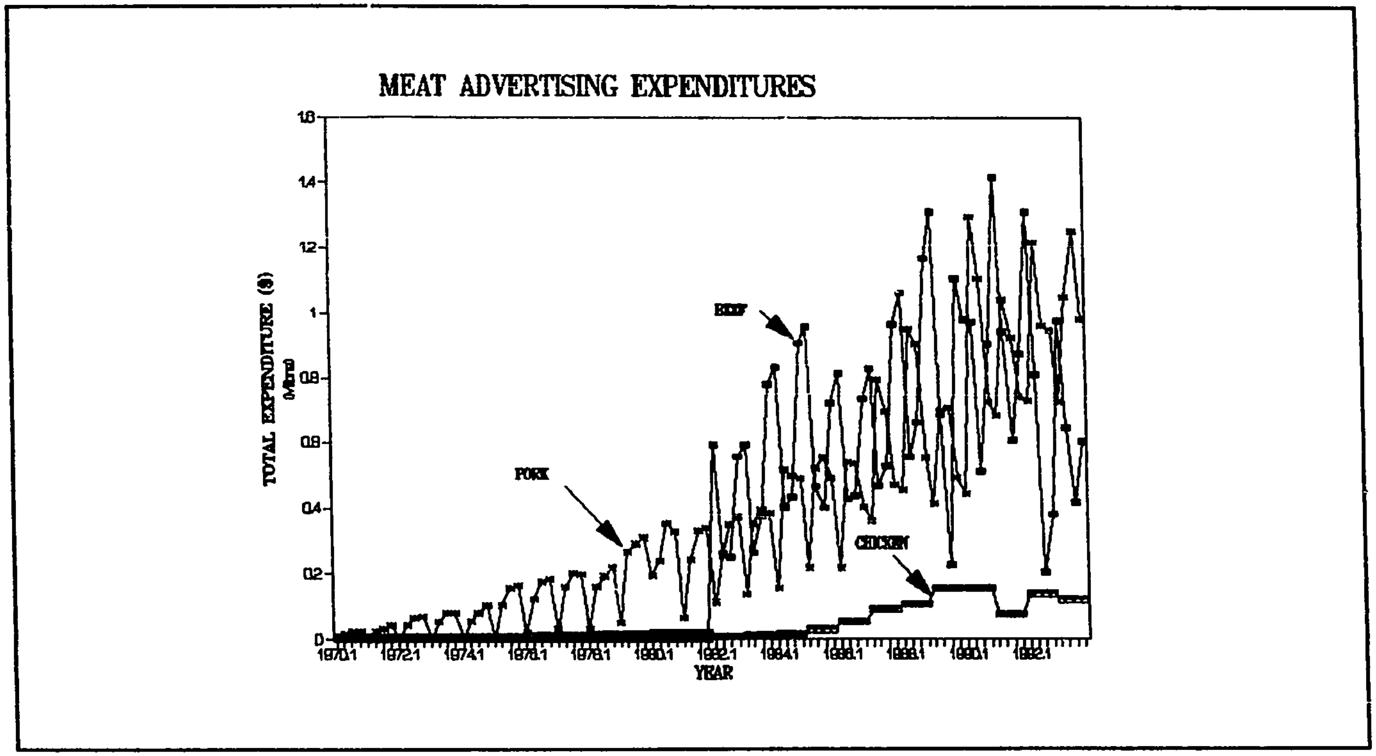
Chapter Two examines some selected studies that assess the influence of advertising and health issues on consumption of foods. In Chapter Three, the theoretical framework to incorporate advertising and health factors to the theory of consumer demand is developed. In Chapter Four an outline of the derivation of the econometric models is presented. The data and the estimation procedures are outlined in Chapter Five. Results and discussion of these results follows in the final chapter which also includes a summary of the findings and the conclusions that are drawn from the study.

FIGURE 1



Source: Extrapolated from Statistics Canada data on annual disappearance, stocks, imports and exports by Agriculture Canada. 1994 (Unpublished)

FIGURE 2



Source: Calculated from data obtained from University of Guelph Generic Advertising Program, Beef Information Centre, and annual reports of provincial meat marketing agencies.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, selected literature is reviewed that relates to information and consumer behaviour; the integration of advertising and health factors into the theory of consumer demand; and the choice of functional form for analysis of the Canadian demand for meats. Particular attention is placed on assessment of generic advertising and the analytical methods that have been used to measure its effect. The use of systems of equations or single equation models is assessed. The issue of seasonal patterns in advertising is also examined in order to assess the appropriateness of methods for measuring the effect of advertising and cholesterol concerns on meat consumption.

2.2 INFORMATION AND CONSUMER BEHAVIOUR

Generic advertising is defined by Forker and Ward (1993) as the cooperative effort among producers of a nearly homogenous product to disseminate information about the underlying attributes of the product to existing and potential consumers for the purpose of strengthening demand for the commodity. This definition can encompass a range of activities that have the purpose of informing and persuading potential users as well as reminding existing consumers of the commodity. Information thus becomes part of the basis of decision making. In situations where consumers make many decisions on daily purchases and consumption, information is important. For frequently consumed products such as meats, experience is also important. The accumulation of these factors translate into consumer demand in that it is usually assumed that the consumer is a rational individual who makes decisions only after having assimilated the appropriate data, analyzed the facts, determined the options, and assessed the constraints (Forker and Ward 1993).

In a study of information and consumer behaviour, Nelson (1970) viewed the acquisition of information as a constraint in the purchasing process. He states that:

> *"Consumers are continually making choices among products, the consequences of which they are but dimly aware. Not only do consumers lack full information about the price of goods, but their information is probably even poorer about the quality variation of products, simply because the latter information is more difficult to obtain."* (p.315)

By disseminating information about the underlying attributes of the product, generic advertising programs seek to control or at least have some impact on the content and flow of information about the commodity to consumers. The ultimate purpose and overall aim for generic advertising is to gain sales and market share. Advertising undertaken by producer groups for meats typically has this purpose.

2.3 ADVERTISING, CHOLESTEROL CONCERNS AND THE THEORY OF DEMAND

Information in and of itself does not create utility. Consumers do not satisfy their basic needs of taste and hunger with information. Product information is a means to an end for fulfilling these needs. Information aids the consumer in deciding the foods and the quantities of these to consume. Some information regarding nutrition, quality and characteristics of a product reaches consumers through advertising and promotion. Information relating to health issues reaches consumers through the media, health authorities, friends and colleagues (Beggs et al. 1993).

There is no consensus as to the method of accounting for the effects of these non-traditional factors in the various demand models where they have been used. Some analysts of consumer behaviour have posited that advertising be viewed as affecting the consumer's perceived attributes of the quality of the advertised product (Kotowitz and Mathewson 1979). Analysts have also suggested that advertising and health factors influence tastes and determine preference orderings and are not necessarily themselves objects over which preferences are defined. Advertising and health concerns can therefore be incorporated into the consumer's utility function by expressing them as quantity-augmenting parameter (Dixit and Norman 1978). The precise mechanism by which the consumer makes decisions involves issues within the domain of psychology and communications, the values and concepts of which are not easy for economists to quantify. This study adopts the approach of Dixit and Norman because as alluded to earlier, it is believed that advertising and health publicity are mechanisms through which consumers are informed about product attributes. The information consumers receive does not create utility but influences their tastes and helps consumers to determine preferences. Dixit and Norman propose that a vector x of quantities of goods and a vector β of product quality parameters (portrayed by advertising and health information) together yield a vector z of characteristics that can be expressed as:

$$z = g(x, \beta) \tag{2.1}$$

They further propose that if, for example, α is a vector of taste parameters, and y the quantity of a *numeraire* good, then preferences over (z,y) may be presented by the utility function

$$u = f(z, \alpha) + y \tag{2.2}$$

Chang and Kinnucan (1991) also argue that consumers' preferences depend on what and how much they know about the product. Therefore, consumers' perceptions of the quality of a good affect the utility experienced in consuming the good. They indicate, further, that a consumer's perceptions of product quality will depend on the information that a consumer has about product attributes. Thus, they specify a consumer's utility function as:

$$U = U(X(Z(N_1, N_2(A)))) \quad (2.3)$$

where N_1 represents unfavourable product information such as health effects provided by sources viewed as credible or neutral, and N_2 represents favourable product information as from successful advertising provided by non-neutral sources.

With these concepts, incorporating advertising into the utility function assumes that advertising alters the marginal utilities of the advertised commodity with respect to other goods. Moreover, it is assumed that with a positive and effective advertising campaign, a consumer maximizing utility allocates the fixed total expenditure to goods according to the new marginal utility rating. This approach assumes that advertising costs are incurred by a seller in an attempt to secure a favourable change in consumer's preference for the advertised product i.e., the seller seeks to increase the marginal utilities of the product on sale with respect to other goods. In terms of a profit maximizing seller, if advertising costs are incurred, the demand curve may shift. Compared with the previous equilibrium situation, a range of outcomes is possible: either a larger quantity may be sold at the same price, the same quantity sold at a higher price, a larger quantity sold at a lower price, or a smaller quantity may be sold at a higher price (Hoos 1959). Such a range of permissible outcomes depends on the nature of the markets and whether there is perfect or imperfect competition. Nevertheless, once the demand curve for a product shifts, both price and quantity are affected.

Under the perfectly competitive framework where there is no price control, several researchers have examined and explained consumer responses to advertised and promoted products and health factors in terms of variables other than prices and income. These factors have been modelled as having a direct link with consumption that cause the demand curve to shift. Other researchers have suggested that there may be effects of such non-traditional factors on the price elasticity of demand and the cross-elasticities of demand with respect to the prices of competing commodities. Quilkey (1986) argues that the link between advertising and consumption is unobservable and that one can only examine the impact of advertising through analyzing changes in price and income elasticities of demand. He writes:

> *"Adjustments in consumer expenditures take place in response to new information. These adjustments take the form of changes in own-price elasticities, cross-price elasticities, budget shares and income elasticities."* (p. 43)

Quilkey concludes that an effective promotion program which stresses uniqueness of the product should lead to less elastic demands of quantity with respect to price. On the other hand, promotion that stresses a product's substitutability for other products in its end uses should, if effective, lead to more elastic demands with respect to price as an outcome of advertising.

A commonly used proxy to account for advertising effects on the utility function is expenditures on advertising. For cholesterol concerns, the proxy used is an index originally constructed by Brown and Schrader (1990) and extended by Chang and Kinnucan. These two measures are used in this study.

2.4 SYSTEMS OF EQUATIONS VERSUS SINGLE EQUATION MODELS

Most empirical studies investigating the impacts of advertising and cholesterol information on demand have used single equation functional forms to estimate demand parameters. However, this has some disadvantages. First, typically these models are generally inconsistent with demand theory in that they do not satisfy integrability conditions, that is, the consistency of a demand system with an underlying utility function. Second, using a single equation approach precludes using cross-equation restrictions (eg. Slutsky symmetry) on parameters to ensure that relationships among elasticities are consistent with demand theory. Finally, by concentrating on a single commodity, there may be important cross-commodity impacts of advertising which are ignored. Nevertheless, single equations have the advantage of simplicity and also provide more flexibility in model specification.

Chang and Kinnucan (1990) used single equation functional forms to model advertising hypothesising this to affect demand directly as well as affect the slope of the demand curve. They report positive own-advertising elasticities for butter, margarine and shortening; and negative own-advertising elasticity for salad oils (where advertising is a shift variable). The variables "own-price*own-advertising" were positive but statistically significant only in the case of butter. The authors conclude that this positive coefficient implies that butter advertising has a positive effect on the own-price elasticity of butter, making butter demand less elastic. This finding is consistent with Quilkey's hypothesis that successful advertising alters the slope of the demand curve and that stressing the unique characteristics of a product through advertising can reduce the substitutability of competing products. Similar results were reported in a study where butter advertising was modelled only as a slope shifter (Chang and Kinnucan 1991).

Brown and Schrader (1990) investigated the effect of cholesterol information on egg consumption in the United States using single equation functional forms. For this purpose, they constructed a "cholesterol information index" which was based on a running total of the number of published articles on cholesterol. In the construction of this index, each article supporting the linkage between cholesterol and heart disease added one unit to the running total (lagged two quarters) and each article refuting the linkage subtracted one unit. The authors, using U.S. quarterly time-series data from 1955.1 to 1987.2, estimated a demand relationship for eggs in a model that included the cholesterol index both as an independent shift parameter and as a variable affecting the slope of the demand curve. In various specifications it was found that the coefficient on cholesterol information, treated as an independent shifter, was consistently and significantly negative. Where cholesterol was modelled as a slope shifter, the coefficient on the variable "price*cholesterol" was positive and significant at 99% level significance. This implies that cholesterol information apparently decreased the own-price elasticity of demand for eggs and that as price dropped, consumption increased less than would have been the case without cholesterol information. The coefficient estimated on the variable "income*cholesterol" was negative and significant at 95% level of significance. This result suggests that cholesterol information may have decreased income elasticity and that as income rose, consumption increased by less than would have occurred without cholesterol information. Chang and Kinnucan (1990) used the cholesterol index constructed by Brown and Schrader as a proxy to measure consumer awareness of cholesterol. Cholesterol awareness was modelled as a demand shifter. The authors reported a negative and statistically significant coefficient on the index in the case of butter. They suggest that the significance of the cholesterol variable implies that health information is relevant for understanding food consumption behaviour.

Analysts who have used a systems approach to study the impacts of advertising on food demand include Capps and Schmitz (1991); Brown and Lee (1992); Cox (1992); Brester and Schroeder (1994); and Brown (1994) all of whom used the Rotterdam model. Green, Carman and McManus (1991); Harris, Dunlop and Vercamen (1992) and Chang and Green (1992) used the linear version of the Almost Ideal Demand System model (LA/AIDS). Goddard and Griffith (1993) and Goddard and Cozzarin (1992) used both AIDS and Translog models. Results reported from these studies are sufficiently varied to suggest that inferences about the economic impacts of commodity advertising programs are sensitive to the functional specification of the empirical assessment of demand. For example, Goddard and Cozzarin examine the performance of both AIDS and Translog functional forms applying static and dynamic models for the simultaneous study of nine commodities: beef, pork, chicken, turkey, eggs, butter, fluid milk, cheese and margarine. Each model is tested using three specifications: one without advertising; one with advertising incorporated as a demand shifter; and one with advertising modelled so as to change the slope of the demand equations. In both the Translog and AIDS models, whether advertising entered as an independent shifter or as affecting the slope of the demand curve, advertising elasticity for beef was consistently negative but for chicken, estimated elasticities were positive. Results were mixed for pork. Income elasticity for chicken in the AIDS model was negative. In both Translog and AIDS models Goddard and Cozzarin found both price and expenditure elasticities to be unity where advertising was incorporated as a demand shifter. In another model formulation, the meats were grouped together and the impact of advertising examined. Using the translog functional form, the authors obtained negative advertising elasticities for beef and pork but positive advertising elasticities for chicken. It is evident that the results were sensitive to the choice of the functional form of AIDS or Translog and to the method of incorporating advertising.

2.5 GENERIC ADVERTISING WEAROUT

Another theoretical issue bearing on the economic analysis of advertising and promotion involves the time distribution of the demand effects which result from advertising. It is now recognized that promotion campaigns may have an effect on demand in subsequent periods to the promotion activity but there is no general agreement on the lag structure of this effect. Specification of carryover effects that have applied in previous studies include modelling effects in terms of an arithmetic average of advertising expenditure in previous periods (Nerlove and Waugh 1961), a finite distributed lag of advertising expenditures (Chang and Kinnucan 1990), a Pascal distribution (Kinnucan and Forker 1986), an Almon distribution (Ward and Dixon 1987) and a moving average or moving sums of advertising expenditures (Aviphant, Lee, and Brown 1988). Duffy (1987), Clements and Selvanethan (1988), Goddard and Cozzarin (1992) and Goddard and Griffith (1993) do not incorporate advertising lags. The lag structure for meat advertising is not known and needs to be investigated empirically. The study does not include any lag structure due to data limitations.

2.6 SEASONALITY IN ADVERTISING

Advertising programs by the various meat producer groups have been planned to follow some seasonal pattern under the presumption that there is some amount of seasonality in meat consumption, as is reported in some studies (see Hassan and Johnson 1979, 1983; Young 1987; Atkins, Kerr and McGivern 1989; and Reynolds and Goddard 1991). In the study of commodities with a seasonal pattern in consumption, it is possible that there may be the existence of a seasonal relationship between consumption of the product and advertising publicity. Such a phenomenon can be tested using dummy variables (Trividi and Lee 1981). Kinnucan and Forker (1986) use single equation functional forms to examine seasonality in the consumer response to milk advertising. They reported that the specification which permitted seasonal variation in the advertising effect (the variable "seasonal dummy*advertising") were all statistically significant at 99% level.

In summary, the review of selected studies cited above indicate that there is a difference of opinion about how advertising and cholesterol information should be incorporated into demand theory and how best to model the effects of advertising and cholesterol information. There have been various approaches to modelling the effects of advertising and health concerns in the demand function. These include incorporating these factors in the demand function such that they directly cause a shift in the demand curve; and incorporating the factors to affect the slope of the demand curve. Both approaches seem plausible. The possibilities of a carryover or lag effect and seasonality in advertising effectiveness and activity cannot, however be overlooked.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 INTRODUCTION

In this chapter a suitable model for evaluating the effect of prices, income, advertising and cholesterol information is derived. In the following section the neoclassical theory of demand is briefly outlined. The subsequent section shows how advertising and health factors are incorporated into the standard model of demand theory.

3.2 NEOCLASSICAL DEMAND THEORY

Following the usual approach to analysis of consumer behaviour, it is assumed that the individual consumer possesses a preference ordering for alternative bundles of commodities and that this ordering can be represented by an ordinal utility (U) function:

$$U = U(X) \tag{3.1}$$

where X = vector of bundles of commodities.

It is required that this preference relationship satisfy some six axioms which indicate rational consumer behaviour and facilitate the maximization procedure:

a) Reflexivity – each bundle of commodities is at least as good as itself.

b) Completeness – the consumer has ability to rank all the bundles.

c) Transitivity – there is consistency in the consumer's ranking.

d) Continuity – the utility function is differentiable to the first and second order.

e) Non-satiation – more of the bundle of commodities is always preferred by the consumer.

f) Convexity – ensures diminishing marginal rate of substitution among bundles of commodities.

Details of demand theory and the basis for these assumptions can be found in any standard economics or consumer theory textbook, such as Deaton and Muellbauer (1992). With the above assumptions satisfied, the individual consumer is assumed to face the choice of maximizing his/her utility function (3.1) subject to a budget constraint:

$$Max. \quad U = (X)$$

$$(3.2) \qquad subject \;\; to \quad M = \sum_{i=1}^{n} p_i x_i \qquad i = 1,2,...,n$$

where: M = the individual's income;

p_i = the price of the i^{th} commodity and

x_i = quantity of i^{th} commodity.

The problem of constrained utility maximization can be solved by maximizing the associated Lagrangean function by setting the partial derivatives equal to zero and solving these simultaneously. The result is the derivation of demand relationships that give quantities as a function of prices and income or total expenditure:

$$(3.3) \qquad x_i = f(p_1, pHx, p_3, ..Hx \; p_n, \; M \;) \qquad i = 1,2,...n$$

These functions are the general forms of the Marshallian demand functions for a commodity. From these functions, expenditure shares can be derived as:

$$(3.4) \qquad w_i = \frac{(p_i * x_i)}{M}$$

where: w_i = expenditure share of the i^{th} commodity.

An alternative approach to the consumer choice problem is one of selecting commodities to minimize the money outlay necessary to reach a predetermined utility level (U). This is expressed as:

$$Min. \quad M' = \sum_{i=1}^{n} p_i x_i$$

(3.5) $$subject \ to \quad U = (X)$$

The solution to the problem (3.5) can also be solved by minimizing the Lagrangean function. This leads to a series of Hicksian or compensated demand functions where:

(3.6) $$x_i = h(p_1, p_2, p_3, \ldots, p_n, U)$$

Utility maximization and cost minimization imply the same choice, as the original or primal and dual problems have the same solution. The solutions in equations 3.3 and 3.6 can be substituted back into their respective problems to derive expressions for the maximum utility (V) and the minimum cost (C) attainable, respectively. Substituting equation 3.3 into 3.1 yields:

(3.7) $$V = V[x_1(P,M), x_2(P,M), \ldots, x_n(P,M)]$$

where V = maximum utility attainable and

P = the vector of relevant prices.

Substituting equation 3.6 into the choice problem in 3.5 yields:

(3.8) $$C = \sum_{i=0}^{n} [p_i x_i(P,U)]$$

where C = minimum cost for attaining U at each price P.

The indirect utility function, equation 3.7, and the cost function, equation 3.8, can be written respectively as:

(3.9) $$V = V(P,M) = Max_x \, [U(X) \, ; \, PX = M]$$

(3.10) $$C = C(P,U) = Min_x [PX \; ; \; U = U(X)$$

Equations 3.9 and 3.10 are related. A rearrangement or inversion of 3.10 results in:

(3.11) $$U = U(P,C)$$

Similarly, inversion of 3.9 results in:

(3.12) $$M = M(P,V)$$

The two functions are simply alternative ways of writing the same information. By *Shephard's Lemma*, it can be shown that the partial derivatives of the cost function, 3.10 with respect to prices are the Hicksian demand functions which express quantities demanded as a function of utility, U and prices, P.

(3.13) $$\frac{\partial C(P,U)}{\partial p_i} \equiv h_i(P,U) = x_i$$

Equation 3.9 expresses utility in terms of P and M so that substitution of equation 3.9 into the Hicksian demand function gives quantities in terms of P and M, or the Marshallian demand functions ie.:

(3.14) $$X_i = h_i(P,U) = h_i[P, V(P,M)] = f_i (P,M)$$

This relationship can also be established in reverse, starting with the Marshallian demands and using the cost function to express M in terms of U and P ie.:

(3.15) $$x_i = f_i(P,M) = f_i[P, C(P,U)] = h_i (P,U)$$

It is also possible to rewrite the partial derivative in equation 3.13 so as to allow derivation of the Marshallian demand function from the indirect utility function. Since the cost and indirect utility functions are inverses, equation 3.9 can be written as:

$$V = V[P, C(P, U)] \tag{3.16}$$

Differentiating 3.16 with respect to p_i with U held constant and using the chain rule gives:

$$\frac{\partial V}{\partial p_i} + \frac{\partial V}{\partial M} \cdot \frac{\partial C}{\partial p_i} = 0 \qquad \textit{where}$$

$$-\frac{\partial V / \partial p_i}{\partial V / \partial M} = \frac{\partial C}{\partial p_i} = x_i = f_i(P,M) \tag{3.17}$$

Equation 3.17 is commonly known as *Roy's identity.*

These relationships provide a general characterization of the properties of Hicksian and Marshallian demand functions. These are summarized below:

1) Adding up – The total value of both Hicksian and Marshallian demands is total expenditure.

2) Homogeneity – The Hicksian demands are homogenous of degree zero in prices, the Marshallian demands are homogenous of degree zero in total expenditure and prices.

3) Symmetry – The cross-price derivatives of the Hicksian demands are symmetric, for all $i \neq j$.

4) Negativity – The *n*-by-*n* matrix formed by the elements $\partial h_i / \partial p_i$ is negative semi-definite.

3.3 ADVERTISING, CHOLESTEROL CONCERNS AND THE UTILITY FUNCTION

Various approaches have been suggested to show how the effects of demographic, stock and other non-price, non-income variables such as advertising publicity and cholesterol concerns are incorporated into the standard model of demand theory. The various approaches are based on the household production function formulation allowing for the consumer's optimization process.

3.3.1 The Household Production Function

Brendt (1991) suggests that households combine the inputs of time, information, and market goods, subject to the constraints provided by a household production function, to provide unobserved, latent commodities that ultimately create value or utility. He indicates that information itself is not freely provided but also requires inputs of time and goods. The production of goods and time in producing information is conditioned by the exogenous amount of advertising messages or information to which the household is exposed. Since advertising is produced by firms, not households, it can be expected to play the role of an exogenous shift variable in the household's production function (Cox 1992). Cholesterol concerns can be incorporated in a similar manner because this may be viewed as 'unfavourable' information or negative advertising (Chang and Kinnucan 1991). The information in and of itself does not create utility but potentially influences the marginal utility of the consumer's demand for the commodity on which information has been obtained.

Cox (1992) suggest that advertising publicity and cholesterol concerns can be incorporated into the utility function using the household production function approach. This may be achieved by assuming that consumers behave as if they optimize a well behaved utility function, a process represented as:

(3.18) $$Max.\quad U(Z_1,Z_2,\ldots,Z_n) \qquad Z>0$$

$$subject\ to \quad Z_i = Z_i(X,A,C,S) \quad and \quad M = \sum_{i=1}^{n} p_i x_i$$

where Z_i = household production function for the i^{th} commodity;

A = vector of advertising expenditure;

C = cholesterol information; and

S = vector of exogenous factors such as seasonality, trends, and demographics.

Cox interprets the Z_i functions as "effective" quantity levels, which are functions of the observed quantities x_i "augmented" in a positive or negative manner by the advertising vector (A) and cholesterol information (C). To make the optimization problem more explicit Z_i can be substituted into the utility function to give:

(3.19) $$Max.\quad U[Z_1(X,A,C,S),\ldots,Z_n(X,A,C,S)]$$

$$subject\ to \quad M = \sum_{i=1}^{n} p_i x_i$$

In the reduced form, equation 3.19 becomes:

(3.20) $$Max.\quad U(x_1,x_2,\ldots,x_n;A,C,S)$$

$$subject\ to \quad M = \sum_{i=1}^{n} p_i x_i$$

where vectors A, C and S are interpreted as exogenous preference shifters as in equation 3.18. The solution to this problem provides a general form of the Marshallian demand function for a commodity where the quantity demanded is a function of prices $p_1,\ldots p_n$, income M, advertising A, cholesterol information C, and seasonality S ie.

(3.21) $$x_i = f(p_1,p_2,p_3,\ldots, p_n,M,A,C,S)$$

The indirect utility function and cost function can likewise be presented, respectively as:

(3.22) $$V = V(p_1,p_2,p_3,\ldots,p_n,M,A,C,S)$$

and

(3.23) $$C = C(p_1,p_2,p_3,\ldots,p_n,U,A,C,S)$$

The Marshallian and Hicksian demand functions can be derived from equation 3.22 and 3.23 respectively, using Roy's identity and Shephard's lemma; i.e.

(3.24) $$-\frac{\partial V/\partial p_i}{\partial V/\partial M} = f(P,A,C,S,M) = x_i \qquad (Roy's\ \ identity)$$

and

$$\frac{\partial C}{\partial p_i} = h_i(P,A,C,S,U) \qquad (Shephard's\ \ lemma)$$

$$and\ \ substituting\ \ for\ \ U$$

(3.25) $$= f(P,A,C,S,V(P,A,M) = x_i$$

where x_i = Marshallian demand function, and

h_i = Hicksian or compensated demand function.

Consistency with the theoretical properties of consumer demand functions outlined under section 3.2 requires that the demand relationships of equation 3.21 should be homogenous of degree zero in prices and income and exhibit negative own price effects (except in the unusual case of Giffen goods and where there is a substantial income effect to overweigh the necessarily negative own-substitution effect). In addition, in the Hicksian demand function, symmetry of cross price effects is a necessary restriction across all goods consumed.

3.3.2 The Direct Effect Approach

This approach is popular and has been used in several studies as for example Nerlove and Waugh (1961), Dixit and Norman (1978), Chang and Kinnucan (1990), Brown and Schrader (1990), Goddard and Cozzarin (1992), and Goddard and Griffith (1994). Based on the formulation in equation 3.25, advertising publicity and cholesterol concerns are modelled to have a direct impact on consumption in a manner whereby they are assumed to cause a shift in the demand curve. This formulation allows the effects of such exogenously determined factors to be directly assessed in terms of elasticities (concise expression of effects), which economists are interested.

Economic theory is clear on the expected signs of own-price effects but less clear on the effect of advertising and cholesterol information on demand. However, one could expect that any demand increase for one commodity that occurs as a result of a change in advertising must necessarily be offset by demand decreases for other products, while total expenditures remain constant. Advertising expenditures and cholesterol information may influence and reflect changes in tastes and preferences. It is expected that cholesterol publicity represents unfavourable product information while advertising activities represent favourable product information. Thus expected signs are positive for own-advertising elasticities, and negative for cross-advertising and cholesterol elasticities. Specifically, *ceteris paribus*, advertising is expected to cause an increase in demand for the advertised product by attracting new consumers and altering the tastes and preferences of former buyers (Nerlove and Waugh, 1961) while cholesterol concerns will cause consumers to reduce meat intake for health reasons.

3.3.3 The Translating (Additive Augmentation) Approach

Pollack and Wales (1980, 1981) argue that the formulation outlined above implies the exogenous parameters are augmentations in the demand functions and therefore a more explicit formulation of the household production functions (Z_i) in equation 3.18 is required. They propose that augmentation may be additive, in which case Cox (1992) suggests that to incorporate advertising, the Z_is may be specified as:

$$(3.26) \qquad Z_i = X_i - T_i(A)$$

where $T_i(A)$ represents some function of the advertising variables that additively augment the observed X_i. Noting that equation 3.26 implies $X_i = Z_i + T_i(A)$ and substituting this relation into the budget constraint in equation 3.18 yields the associated commodity demand functions under the translating (additive augmentation) hypothesis as

$$(3.27) \qquad x_i(p_1,p_2,\ldots,p_n,M,A,C,S) = Z_i\left(\frac{P}{M-\sum_j p_j T_j(A)},C,S\right) + T_i(A)$$

where $P = (p_1, p_2, \ldots p_n)$ and $P/[M - \Sigma_j p_j T_j(A)]$ is the vector of (adjusted income) normalized prices. This normalized price vector basically imposes homogeneity on the price and income terms of the Marshallian demand curve. *The* X_i function represents the Marshallian demand specification of observed quantities (equation 3.21) and *the* Z_i function represents the Marshallian demand for "effective" or additively augmented (translated) quantities. The latter form implies that the demand impacts of advertising-induced preference shifts act like income effects.

3.3.4 <u>The Scaling (Multiplicative Augmentation) Approach</u>

This approach, also attributed to Pollack and Wales (1980, 1981), has been widely used by some researchers in studying ways in which advertising and promotion may affect consumer behaviour. Examples incorporating the approach are Green, Carman and McManus (1991), Brown and Lee (1992), and Brown (1994). The approach models the exogenously determined parameters under the assumption that they induce preference shifts through the price effects. The quantities in the utility function in equation 3.18 are scaled – either multiplied or divided by the parameters (hence termed multiplicative augmentation). In terms of the indirect utility function or cost function, parameterization takes the form of interactions between prices and these exogenously determined parameters. This implies that a change in an exogenous parameter, such as advertising, has an effect similar to a change in price. Brown and Lee (1992) suggest that the consumer choice problem allowing for the impact of advertising through "scaling" can be written as:

$$(3.28) \qquad Max. \quad U = (X^s) \qquad subject \ to \quad M = \sum_{i=1}^{n} p_i^s x_i^s$$

where x^s_i = $b_i x_i$, an adjusted or perceived quantity.

p^s_i = p_i/b_i, an adjusted or perceived price and

b_i = $b_i(a_i)$, a scaling parameter which depends on own-advertising.

Using the Lagrangean function, and setting the partial derivatives to zero, the resulting demand functions for the above problem (3.28) have the form:

$$(3.29a) \qquad x_i^s = x_i^s(p_1^s,...p_n^s,M) \qquad or$$

$$(3.29b) \qquad x_i = \frac{1}{b_i} x_i \ (p_i^s ,... ,p_n^s,M)$$

Substituting equation 3.29a into the utility function (3.28) results in an indirect utility function and cost function respectively:

$$(3.30) \qquad V = V(p_1^s,...,p_n^s,M)$$

and

(3.31) $$C = C(p_1^s, \ldots p_n^s, M)$$

This approach assumes that advertising for commodity *i* affects the perceived quantity and price for commodity *i*, but does not affect the perceived quantities and prices for other commodities, that is $b_i \neq b_i(a_j)$, but $b_i = b_i(a_i)$, for all *i*. For this specification, own-advertising modifies the marginal utilities and acts as a deflator of the real price.

3.4 SEPARABILITY AND TWO-STAGE BUDGETING

A comprehensive analysis of consumer demand will include all the commodities in the consumer budget. However, this approach usually faces problems of degrees of freedom due to the large number of parameters to be estimated as compared to the number of observations obtainable. A response to this issue is possible if commodities can be partitioned into groups so that preferences within groups can be described independently of quantities in other groups. Commodities which bear special relationships to one another in consumption as substitutes or complements can be said to constitute one group.

The consumer is also assumed to allocate his/her total disposable income in two stages. Assuming weak separability, the consumer allocates total disposable income first to broad groups of commodities such as meats, beverages, housing, transport etc. Then the expenditure allocated to a particular group is allocated among individual consumption items within that group (eg., beef, pork and chicken) depending on prices, and tastes, which can be presumed, may be affected by information on the items transmitted, for example, by advertising activities and cholesterol information.

3.5 AGGREGATION

The theory outlined above relates to the behaviour of an individual consumer. In practice analysts usually use aggregated data derived by summing quantities consumed and expenditures across individual consumers in empirical work. The question arises as to whether aggregate data reflect relationships which hold at the level of the individual consumer, or whether the relationships become distorted in the aggregation process. In practice, the approach taken in response to the aggregation problem is to divide aggregate figures on quantities and income by the population level and to assume that the magnitudes so derived reflect actions on the part of a typical consumer whose behaviour is consistent with the theory outlined earlier in this chapter.

The problem of aggregation is aggravated when advertising and cholesterol concerns are considered because each individual may react differently to a particular advertisement or cholesterol publicity. Some researchers have used per capita advertising expenditure levels but others have used aggregate advertising expenditures. Data availability is a constraint to any extensive analysis of consumer reactions to information because the precise mechanism by which the consumer makes decisions supposedly falls within the domain of psychology and communications rather than the values and concepts of economists. (Chang and Kinnucan 1990).

CHAPTER 4

ECONOMETRIC MODELS

4.1 INTRODUCTION

In this chapter, the econometric models that are to be estimated in the study are outlined. This involves outlining the general specification regarding choices relating to functional form, variables, and separability assumptions.

4.2 SPECIFICATION CHOICES

Very few studies have been done on the effects of generic advertising of meat on meat consumption in Canada. Goddard and Cozzarin (1992) and Goddard and Griffith (1993) are the only researchers who have published studies which examined the impact of advertising on meat consumption in Canada. Functional forms used in these studies include single equations models, typically semilogarithmic or double logarithmic functions, as well as the Translogarithmic and the Almost Ideal Demand System (AIDS) models. Estimates from the studies indicate that their results were sensitive to the functional form chosen. Chalfant and Alston (1988), point out:

> "*Picking a functional form is a means of imposing prior beliefs on a demand system in an attempt to glean more information from the data set. However, we would expect that no one has any priors about functional forms, apart from a requirement that they be compatible with economic theory.*" (p. 405)

Given lack of prior knowledge about how advertising might affect the demand for meats, there is little guidance in choosing specific functional forms. Nevertheless, there are valid reasons to estimate a flexible functional form model which will allow the restrictions from economic theory described in Chapter 3 to be incorporated and cross-commodity effects from advertising, if any, be captured. A flexible functional form will also allow the data to determine the form of the demand relationship. This will involve approximating a direct utility function, an indirect utility function or a cost/expenditure function by some specific functional form that has enough parameters to be a reasonable approximation to whatever the true function may be. Diewert (1991) describes a demand function considered as flexible functional form to be one derived from an aggregator function (direct or indirect utility function, expenditure function) which is a second-order approximation to the relevant true one. Thus the demand functions themselves are first-order approximations and there is some point in the space of exogenous variables where the derivatives of these approximate demand functions are equal to the true ones. The Indirect Translogarithmic, the AIDS and the Rotterdam systems are examples of flexible functional forms. Barten (1993) is of the opinion that flexibility expresses itself in the ability to explain the data as well as the system used to generate the data. Given the lack of a priori knowledge in making a choice among the alternatives available, linear versions of the Rotterdam and the AIDS functional forms were chosen to determine how sensitive results will be to model choice. It is also thought necessary to compare the relative performance of the two functional forms since both models are applied to the same set of data.

The models chosen have not been free of criticisms. Chang and Kinnucan (1992) report counter-intuitive results from applying the linear version of the AIDS model (LA/AIDS) to the effect of advertising on consumption of fats and oils in Canada. Estimated expenditure coefficients for butter and shortening were negative; out of fifteen advertising coefficients estimated, only two were significant and had a negative sign. Chang and Green (1992) obtained mixed results for food in assessing the effect of advertising. Goddard and Cozzarin (1992) also conclude that the results from advertising effects on demand are sensitive to functional form and to the method of incorporating advertising.

In both models, the restrictions from economic theory will be imposed in order to increase the precision of estimates and the power of hypothesis tests.

4.3 CHOICE OF VARIABLES

The weakly separable meat group is assumed to consist of beef, pork and chicken. Although turkey, lamb, mutton and fish are considered as part of this group, they were excluded due to the relatively low consumption expenditure on them, their exclusion from most previous studies and a lack of data. This may be a shortcoming of the specification. The implication of this specification choice is that the expenditure variable to be used in the models is total expenditure on the weakly separable meat group rather than expenditure on all meats. Meat expenditure, prices, actual advertising expenditures and an index of cholesterol publicity are included in each model. Since quarterly data are being used seasonal dummy variables were included to capture seasonality in consumer behaviour.

4.4 MODEL FORMULATION

4.4.1 The Almost Ideal Demand System (AIDS)

The AIDS model is attributed to Deaton and Muellbauer (1980). It is derived, by the use of duality concepts, from the flexible consumer expenditure function known as the price-independent generalized logarithmic (PIGLOG) form. The expenditure function as defined by Deaton and Muellbauer is the minimum expenditure necessary to attain a given level of consumer utility at given current prices. The expenditure function is specified as:

$$\ln[c(u,p)] = (1-u)\ln[a(p)] + u\ln[b(p)] \quad (4.1)$$

where, u = utility and lies between 0 (subsistence) and 1 (bliss) so that a(p) and b(p) can be regarded as the costs of subsistence and bliss respectively; and

p = a vector of prices.

Deaton and Muellbauer define ln[a(p)] and ln[b(p)] as:

$$\ln[a(p)] = \alpha_o + \sum_i \alpha_i \ln(p_i) + \frac{1}{2}\sum_i \sum_j \gamma^*_{ij} \ln(p_i)\ln(p_j) \tag{4.2}$$

and

$$\ln[b(p)] = \ln[a(p)] + \beta_o \prod_i p_i^{\beta_i} \tag{4.3}$$

Substituting (4.2) and (4.3) into (4.1) gives an expression for the AIDS expenditure function which can be written as:

$$\ln[c(u,p)] = \alpha_o + \sum_i \alpha_i \ln(p_i) + \frac{1}{2}\sum_i \sum_j \gamma^*_{ij} \ln(p_i)\ln(p_j) \tag{4.4}$$

$$+ u\beta_o \,{}_i\, p_i^{\beta_i}$$

where α_0, α_i, γ^*_{ij}, β_0, and β_i are unknown parameters. The generalized AIDS model can be derived from (4.4) using *Shephard's Lemma* and substituting for *u*; Deaton and Muellbauer (1980) provide the detailed derivation of this model. The resulting demand functions in expenditure share form are:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \,[\ln(M) - \ln(P)] \tag{4.5}$$

where, w_i = expenditure share of meat *i*,

$\ln(p_j)$ = log of price of meat *j*,

$\ln(M)$ = log of meat expenditure, and

$\ln(P)$ = price index expressed as;

$$\ln(P) = \alpha_o + \sum_j \alpha_j \ln(p_j) + \frac{1}{2}\sum_j \sum_i \gamma_{ij} \cdot \ln(p_i)\ln(p_j) \tag{4.6}$$

The restrictions on the parameters of (4.5) include adding-up, $\sum_j \alpha_j = 1$, $\sum_j \beta_j = 0$, $\sum_j \gamma_{ij} = 0$; homogeneity, $\sum_i \gamma_{ij} = 0$; and symmetry, $\gamma_{ij} = \gamma_{ji}$.

The standard AIDS specification (4.5) is non-linear in parameters and is approximated by its linearised version, known as the linear approximation (LA) version of the AIDS demand system. The LA/AIDS model in share form for a group of *n* commodities is similar to (4.5) except that the non-linear AIDS price index (4.6) is replaced with Stone's linear approximate price index where the latter is defined as:

$$\ln(P) \approx \ln(P^*) = \sum_j w_j \ln(p_j) \qquad (4.7)$$

To include the effects of particular non-price and non-income exogenous variables as independent demand shifters, Green (1985) suggests that the α_i's in (4.5) should be modified. To incorporate a time factor, seasonality, advertising publicity and cholesterol concerns, if these are modelled to have such an effect, essentially a direct effect analogous to an intercept shifter, on consumption, the α_i's should conform to the following scheme:

$$\alpha_i = \alpha_i^* + \sigma_i T + \sum_{k=1}^{4} \lambda_{ik} S_k + \sum_{j=1}^{n} \delta_{ij} A_j + \tau_i C \qquad (4.8)$$

where, T = time,

S_k = quarterly dummies, representing seasonality.

A_j = advertising publicity or expenditures on of meat j.

C = cholesterol index,

λ_{ik}, δ_{ij} & τ_i are coefficients to be estimated. For ease of estimation all models are estimated as linear versions of the AIDS model. The system of equations 4.5 incorporating time, cholesterol index, quarterly dummies, and an error term was estimated as Model I; Equation 4.5 incorporating time, cholesterol index, quarterly dummies, an error term as well as advertising expenditures was estimated as Model II.

The responsiveness of meat consumption to advertising may vary with the seasons, since advertising and promotion programs are scheduled with the seasons, namely;

summer, fall, winter and spring[1]. The existence of a seasonal relationship between meat consumption and advertising expenditures could be tested using quarterly dummies (see Kinnucan and Forker 1986). This approach, however, is costly in terms of degrees of freedom, considering the number of observations of the data series. As a result, in this study, a third model is assessed in which, for seasonality in advertising, the four seasons are grouped into two; fall and winter seasons are treated as one and season spring and summer as another. The α_i's can then be presented as:

$$(4.9) \qquad \alpha_i = \alpha_i^* + \sigma_i T + \sum_{k=1}^{4} \lambda_{ik} S_k + \sum_{j=1}^{n} \theta_{ij}(A_j * S_{1,4}) + \sum_{j=1}^{n} \phi_{ij}(A_j * S_{2,3}) + \tau_i C$$

where $A_j{}^*S_{1,4}$ and $A_j{}^*S_{2,4}$ represent advertising of the j^{th} commodity in fall/winter and spring/summer respectively. Equation 4.5 incorporating the definition of α_i in 4.9 and an error term is estimated as Model III. In the above framework, the restrictions of adding-up, homogeneity and symmetry are preserved on the modified parameters, ensuring that the modified models are compatible with theory. The null and alternative hypothesis to be tested are:

H_0 = Advertising expenditures by the respective producer groups and cholesterol information as represented by the cholesterol index have not affected consumption of beef, pork and chicken.

H_1 = Advertising expenditures by the respective producer groups and cholesterol information have affected consumption of beef, pork and chicken.

Another approach to assessing the impact that advertising may have in changing

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[1]This is elaborated in chapter five in which the construction of the advertising data series is outlined.

preferences and demand is through scaling effects on quantities in the utility function, an alternative way to model the effects of changes in demographic, informational or non-price and non-income influences. This approach is used by Duffy (1987) and Green, Carman and McManus (1991) to incorporate the effects of advertising in modifying marginal utilities of consumption. The basic feature of this approach is that the quantities in the utility function are scaled, being multiplied or divided by parameters reflecting exogenous fac s. In this case, the effect is modelled by multiplication of the inverse of the advertising variable, because it is expected that if there is an increase in the price of a commodity, an increase in advertising will offset any tendency for a decrease in consumption. In terms of the indirect utility function or cost function, parameterization takes the form of interactions between prices and the advertising variable. This implies that a change in advertising has an effect similar to a change in price. Brown and Lee (1992) indicate that "scaling" the price variable in this manner is a potential source of restriction on the specification. Allowing for the impact of advertising through scaling, and noting that $\ln(p_i/A_i)=\ln p_i-\ln A_i$, the cost function for the AIDS model can be written as:

$$(4.10)\qquad \ln[c(u,\frac{p}{A})] = \alpha_o+\sum_i \alpha_i[\ln(p_i)-\ln(A_i)]+\frac{1}{2}\sum_i\sum_j \gamma^*_{ij}[\ln(p_i)-\ln(A_i)][\ln(p_j)-\ln(A_j)]+u\beta_o\prod_i p_i^{\beta_i}$$

By applying Shephard's Lemma, inverting, and substituting for *u* the following AIDS model is obtained:

$$(4.11)\qquad w_i = \alpha_i + \sum_j \gamma_{ij}[\ln(p_j) - \ln(A_j)] + \beta_i[\ln(M)-\ln(P)] + e_i$$

$$i,j = 1,2,\dots n$$

where, e_i is an error term and the nonlinear price index lnP is as follows:

$$(4.12) \quad \ln(P) = \alpha_o + \sum_i \alpha_i[\ln(p_i) - \ln(A_i)] + \frac{1}{2}\sum_i \sum_j \gamma_{ij}^*[\ln(p_i) - \ln(A_i)] * [\ln(p_j) - \ln(A_j)]$$

The theoretical restrictions of adding-up, homogeneity and symmetry hold globally for the specification of Equation 4.11 (Green, Carman and McManus 1991). The model implies that advertising affects demand in a direct way and also indirectly through the real income term. As in previous models, the intercept term in Equation 4.11 may still account for such demand shifters as seasonality and cholesterol information as well as a time trend as expressed in Equation 4.8 but without advertising. Advertising, in this formulation, is modelled as having a scaling influence and the full LA/AIDS model may be expressed as:

$$(4.13) \quad w_i = \alpha_i^* + \sigma_i T + \sum_{k-1}^{4} \gamma_{ik} S_k + \tau_i C + \sum_j \gamma_{ij}[\ln p_j - \ln A_j] . \beta_i[\ln(M) - \ln(P^*)]$$

Equation 4.13 is estimated as Model IV. It is implied from Equation 4.13 that real prices are "perceived" in their scaled form, in essence, treating advertising as a price deflator since $\ln(p_i/A_i)=\ln p_i-\ln A_i$. Thus explicit coefficients of the impact of advertising are not directly estimated and its impact will be wholly captured by the coefficient on scaled prices. More specifically, the terms in parenthesis in Equation 4.11 can be written as $\ln p^s_i=\ln(p_i/A_i)$ and (4.13) can be rewritten as:

$$(4.14) \quad w_i = \alpha_i + \sum_j \gamma_{ij}\ln(p_j^S) + \beta_i[\ln(M)-\ln(P^S)] + e_i$$

Advertising elasticities can be derived indirectly from Equation 4.14 by decomposition of the estimated coefficient, γ_{ij} and using Equation 4.5 as a base model. The basis of this decomposition is specified in Appendix A. The formulation decomposes the effects of advertising from price effects when advertising is modelled as a deflator of prices. The decomposition is derived from a general demand function where demand is a function of price and advertising. Equation 4.14 is estimated as Model V and a composite model incorporating advertising as an independent shifter in Equation 4.14 is estimated as Model IV. A summary of the estimated models are presented in Table 4.1.

Table 4.1 Estimated Models of the LA/AIDS Specification[a]

MODEL	ESTIMATED MODEL
I	$w_i = \alpha_i^* + \sigma_i T + \sum_{k=1}^{4} \lambda_{ik} S_k + \tau_i C + \sum_j \gamma_{ij} \ln p_j + \beta_i [\ln(M) - \ln(P)] + e_t$
II	$w_i = \alpha_i^* + \sigma_i T + \sum_{k=1}^{4} \lambda_{ik} S_k + \tau_i C + \sum_{j=1}^{n} \delta_{ij} A_j + \sum_j \gamma_{ij} \ln p_j + \beta_i [\ln(M) - \ln(P)] + e_t$
III	$w_i = \alpha_i^* + \sigma_i T + \sum_{k=1}^{4} \lambda_{ik} S_k + \tau_i C + \sum_{j=1}^{n} \theta_{ij}(A_j * S_{1,4}) + \sum_{j=1}^{n} \phi_{ij}(A_j * S_{2,3}) + \sum_j \gamma_{ij} \ln p_j + \beta_i [\ln(M) - \ln(P)] + e_t$
IV	$w_i = \alpha_i^* + \sigma_i T + \sum_{k=1}^{4} \lambda_{ik} S_k + \tau_i C + \sum_j \gamma_{ij} [\ln p_j - \ln A_j] + \beta_i [\ln(M) - \ln(P)] + e_t$
V	$w_i = \alpha_i^* + \sigma_i T + \sum_{k=1}^{4} \lambda_{ik} S_k + \tau_i C + \sum_j \gamma_{ij} \ln(p_j^s) + \beta_i [\ln(M) - \ln(P)] + e_t$
VI	$w_i = \alpha_i^* + \sigma_i T + \sum_{k=1}^{4} \lambda_{ik} S_k + \tau_i C + \sum_j \delta_{ij} \ln A_j + \sum_j \gamma_{ij} \ln(p_j^s) + \beta_i [\ln(M) - \ln(P)] + e_t$

[a] All variables are as defined earlier.

4.4.2 The Rotterdam Model

The derivation of the Rotterdam model is attributed to Barten (1964) and Theil (1965). Its specification is derived from a system of demand equations in which consumption depends on prices and incomes in the manner represented in equation (3.3). Totally differentiating (3.3) results in:

$$dx_i = \frac{\partial f_i}{\partial p_1}dp_1 + \ldots + \frac{\partial f_i}{\partial p_n}dp_n + \frac{\partial df_i}{\partial M}dM \tag{4.15}$$

Using the property that dlnx=dx/x, and multiplying both sides through by $1/x_i$ and each right hand term by P_j/P_j, gives the expression;

$$d\ln x_i = \sum_j \epsilon_{ij} d\ln p_j + \eta_i d\ln M \tag{4.16}$$

where ϵ_{ij} = uncompensated price elasticity and

η_i = income/expenditure elasticity.

Substituting the Slutsky relationship, expressed in elasticity terms, for the uncompensated price elasticities (since $\epsilon^*_{ij} - w_j\eta_i = \epsilon_{ij}$, where ϵ^*_{ij} is the compensated demand elasticity) and multiplying both sides through by w_i results in the expression:

$$w_i d\ln x_i = \beta_i(d\ln M - \sum_j w_j d\ln p_j) + \sum_j \gamma_{ij} d\ln p_j \tag{4.17}$$

where $\beta_i = w_i\eta_i$ and $\gamma_{ij} = w_i\epsilon^*_{ij}$.

For empirical work which involves discrete observations, the logarithmic differentials (dln's) of variables are replaced by their logarithmic first difference ($\Delta \ln x_i = \ln x_{i,t} - \ln x_{i,t-1}$) and the w_is are replaced by $w_i = 0.5(w_{i,t} + w_{i,t-1})$. Examples are Duffy (1987), Brown and Lee (1992), Cox (1992), Brester and Schroeder (1994), and Brown (1994). The Rotterdam model for each of *n* demand equations in the system is therefore expressed as:

$$\bar{w}_i \Delta\ln x_i = \beta_i d\Delta\ln m + \sum_j \gamma_{ij} \Delta\ln p_j \qquad i,j = 1,2,\ldots,n \tag{4.18}$$

where

$$(4.19) \qquad d\Delta \ln m = d\Delta \ln M - \sum_j w_j \Delta \ln p_j = \sum_j w_j \Delta \ln x_j$$

Equation 4.19 represents a Divisia volume index expressing the change in real income. Seasonal dummies, advertising publicity and cholesterol publicity can be incorporated into the Rotterdam model in a similar fashion to the AIDS or LA/AIDS models. Several previous studies incorporate these factors as having a direct effect on demand and therefore, as shifters of the demand functions[2]. The logarithmic differential of equation 3.21 can be presented as:

$$(4.20) \qquad \bar{w}_i \Delta \ln x_i = \beta_i \Delta \ln m + \sum_j \gamma_{ij} \Delta \ln p_j + \sigma_i T + \sum_k b_{ik} \Delta S_k + \sum_j s_{ij} \Delta \ln A_j + r_i \Delta \ln C + e_i$$

$$i,j = 1,\ldots n; \quad k = 1,\ldots,4$$

where $b_{ik}=w_i\lambda_{ij}$; $s_{ij}=w_i\delta_{ij}$; and $r_i=w_i\tau_i$.

For quarterly dummies, only differentials are taken. A time factor is also included to capture the trend in the dependent variable. Equation 4.20 which excludes advertising as a variable is estimated and is compared to Model I which has the LA/AIDS specification. Similarly, the full specification of Equation 4.20, in which the advertising variable operates as an intercept shifter, is estimated and compared to Model II. To test for seasonality in advertising, the Rotterdam model can be specified as:

$$(4.21) \qquad \bar{w}_i \Delta \ln x_i = \beta_i \Delta \ln m + \sum_j \gamma_{ij} \Delta \ln p_j + \sigma_i T + \sum_k b_{ik} \Delta S_k + \sum_j q_{ij} \Delta \ln (A_j * S_{1,4}) + \sum_j h_{ij} \Delta \ln (A_j * S_{2,3}) + r_i \Delta \ln C + e_i$$

where $q_{ij}=w_i\theta_{ij}$; $h_{ij}=w_i\phi_{ij}$; and all variables as defined previously.

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[2]See Duffy (1987), Brown and Lee (1992), Cox (1992), Brester and Schroeder (1994), and Brown (1994).

Equation 4.21 is estimated to compare with Model III which has the LA/AIDS specification.

Allowing for the effect of advertising through "scaling" which involves the multiplicative augmentations of the price terms which are multiplied by the inverse of the advertising variable, Brown and Lee suggest that a logarithmic differential of equation (3.29b) can be presented as:

$$\bar{w}_i \Delta \ln x_i = \beta_i d\Delta \ln m + \sum_j \gamma_{ij}(\Delta \ln p_j - \Delta \ln A_j) \tag{4.22}$$

where

$$d\Delta \ln m = d\Delta \ln M - \sum_j w_j(\Delta \ln p_j - \Delta \ln A_j) \tag{4.23}$$

With a time trend, seasonal dummies and cholesterol information index incorporated, 4.22 can be presented as:

$$\bar{w}_i \Delta \ln x_i = \beta_i d\Delta \ln m + \sum_j \gamma_{ij}(\Delta \ln p_j - \Delta \ln A_j) + \sigma_i T + \sum_j b_{ik}\Delta S_k + r_i \Delta \ln C + e_i \tag{4.24}$$

The specification in 4.24 is modelled such that advertising affects consumption directly, allowing a direct estimation of advertising elasticities. This specification is estimated and compared with Model IV of the LA/AIDS specification. Allowing advertising to act as a deflator of real price, equation (4.22) becomes:

$$\bar{w}_i \Delta \ln x_i = \beta_i (d\Delta \ln M - \sum_j w_j \Delta \ln p_j^s) + \sum_j \gamma_{ij} \Delta \ln p_j^s \tag{4.25}$$

Equation 4.25 incorporating a time trend, seasonal dummies, the cholesterol index, and an error term is estimated to compare with Model V in the LA/AIDS specification. The linear version of the Rotterdam model incorporating advertising, time, seasonal dummies and the cholesterol index and thus the comparison model, equivalent to Model VI of the LA/AIDS model specification, can be expressed as:

(4.26) $$\bar{w}_i \Delta \ln x_i = \beta_i (d\Delta \ln M - \sum_j w_j \Delta \ln p_j^s) + \sum_j \gamma_{ij} \Delta \ln p_j^s$$

$$+\sigma_i T + \sum_k b_{ik} S_{ik} + \sum_j s_{ij} \Delta \ln A_J \ + r_i \Delta \ln C + e_i$$

4.4.3 Single-Equation Models

For comparative purposes, the six models for each of the two functional form specifications as outlined above were also estimated in single-equation log-linear forms. Summarized, the models are outlined below.

Model I:

(4.27) $$\ln x_i = \alpha_i + \sum_j \epsilon_{ij} \ln p_j \ + \eta_i \ln M + \sigma_i T + \tau_i \ln C$$

$$+ \sum_k^4 \lambda_i S_{ik} + e_i$$

Model II:

(4.28) $$\ln x_i = \alpha_i + \sum_j \epsilon_{ij} \ln p_j + \eta_i \ln M + \sigma_i T + \tau_i \ln C$$

$$+ \sum_k^4 \lambda_i S_{ik} + \sum_j \delta_{ij} \ln A_j + e_i$$

Model III:

(4.29) $$\ln x_i = \alpha_i + \sum_j \epsilon_{ij} \ln p_j + \eta_i \ln M + \sigma_i T + \tau_i \ln C + \sum_k^4 \lambda_i S_{ik}$$

$$+ \sum_j \theta_{ij} (\ln A_j * S_{1,4}) + \sum_j \phi_{ij} (\ln A_j * S_{2,3}) + e_i$$

Model IV:

(4.30)
$$\ln x_i = \alpha_i + \sum_j \epsilon_{ij}(\ln p_j - \delta_j \ln A_j) + \eta_i \ln M + \sigma_i T + \tau_i \ln C + \sum_k^4 \lambda_i S_{ik} + e_i$$

Model V:

(4.31)
$$\ln x_i = \alpha_i + \sum_j \epsilon_{ij} \ln p_j^s + \eta_i \ln M + \sigma_i T + \tau_i \ln C + \sum_k^4 \lambda_i S_{ik} + e_i$$

Model VI:

(4.32)
$$\ln x_i = \alpha_i + \sum_j \epsilon_{ij} \ln p_j^s + \eta_i \ln M + \sigma_i T + \tau_i \ln C + \sum_k^4 \lambda_i S_{ik} + \sum_j \delta_{ij} \ln A_j + e_i$$

where all variables are as previously defined.

4.5 A Pair-wise Comparison of the LA/AIDS versus Rotterdam Models

The LA/AIDS and Rotterdam models considered in the preceding sections are not nested. Following Barten (1993), the two systems can be considered to be represented by:

(4.33)
$$Y_{it} = \beta_j X_t + u_{jt}$$

where the *n*-vector Y_{it} represents the j-th nonlinear data transformation of a vector of basic endogenous variables. The matrix X_t is a *n x k* matrix of exogenous variables and β_j is a vector of coefficients, specific to each system. The *n*-vector u_{jt} contains disturbance terms. For the two systems, let j=1, 2 for the LA/AIDS and Rotterdam models respectively and construct the following general model:

$$\alpha_1(Y_{1t} - X_t\beta_1) + \alpha_2(Y_{2t} - X_t\beta_2) = v_t \tag{4.34}$$

Barten contends that no loss of generality is involved by letting $\alpha_1+\alpha_2=1$ or $\alpha_1=1-\alpha_2$. Thus the general model is:

$$(1 - \alpha_2)Y_{1t} + \alpha_2 Y_{2t} = ((1-\alpha_2)\beta_1 + \alpha_2\beta_2)X_t + v_t$$

$$Y_{1t} = ((1-\alpha_2)\beta_1 + \alpha_2\beta_2)X_t + \alpha_2(Y_{1t} - Y_{2t}) + v_t \tag{4.35}$$

From 4.35, it can be tested whether the estimate of α_2 is significantly different from zero. If α_2 is not statistically different from zero, the LA/AIDS model explains the data adequately and that the Rotterdam model is not important in a general model specification needed for parametric analyses as in 4.34. On the other hand if α_2 is significantly different from zero, then both LA/AIDS and Rotterdam models are important to specify a general model as in 4.34.

CHAPTER 5

DATA SOURCES AND ESTIMATION PROCEDURE

5.1 INTRODUCTION

In this chapter the data used in the thesis research are discussed. Each variable and/or the proxy used for each variable is defined. The nature and sources of the data and the procedure used to derive each variable is outlined as are any limitations of the data. The various estimation procedures are also outlined in this chapter.

5.2 PRICES AND CONSUMPTION OF MEATS

Data series on per capita consumption and prices for beef, pork and chicken were available from Agriculture Canada. This provided quarterly consumption data which consisted of per capita disappearance of chicken (kilograms) in eviscerated weight; per capita disappearance of beef (kilograms) in carcass weight; and per capita disappearance of pork (kilograms) also in carcass weight for the period from 1965 to 1993. The carcass weight of beef and pork were converted to retail weight using respective conversion factors suggested by Hewston (1987) and Hewston and Rosien (1989). The conversion factors are percentages which allow the retail weight to be a proportion of the carcass weight to account for fat and bone trimmed before meat is sold. Table 5.1 presents the conversion factors used.

Retail prices for the various meat types were calculated[1]. The calculations transformed Consumer Price Index (CPI) for meats data published by Agriculture Canada and Statistics Canada into retail price series. The conversion was based on 1986 city average retail prices for the various cuts; these were combined by using the weights used in calculating the overall CPI (Tables 44 and 45, pp. 90 and 91 respectively in Handbook

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[1]Dr. James Eales of Purdue University provided the calculated retail price data series.

Table 5.1: Conversion Factors: Carcass to Retail Weight.

BEEF		PORK	
FACTOR	PERIOD	FACTOR	PERIOD
0.76	1967.1 - 1978.4	0.79	1967.1 - 1969.4
0.74	1979.1 - 1985.4	0.78	1970.1 - 1975.4
0.73	1986.1 - 1992.4	0.77	1976.1 - 1982.4
		0.76	1983.1 - 1992.4

Source: Food Marketing Commentary 1987 and 1989. Agriculture Canada Publication Cat. # A80-751.

of Food Expenditures, Prices and Consumption 1990). The cuts priced in 1986 for each meat type were divided by the percentage of meat type and multiplied by the corresponding prices and summed. For example, beef cuts were specified as follows: Hip cuts were taken to be represented by round steak; loin cuts by sirloin steak; rib cuts by prime rib roast; chuck cuts by average of blade roast, blade in and blade out; stewing cuts by stewing beef; and ground beef by hamburger. The category "all other beef" was not included in the calculation. In Table 5.2, the second column represents the proportion of total consumer expenditures in 1986 spent on beef and beef cuts. The third column is a weighted average retail price from twenty six (26) cities across Canada. The fourth column represents the proportion of each cut in terms of the base year price. These proportions are summed to obtain the base year price. To calculate the prices for the other years, the base year price is divided by 100 and multiplied by the respective CPI. With such calculations, it is assumed that weights of cuts are constant through time. Similar calculations were made for pork and chicken.

TABLE 5.2 : Calculation of beef prices using the Consumer Price Index

BEEF TYPE	% OF 1986 EXPENDITURE PROPORTION	WEIGHTED AVERAGE CITY RETAIL PRICE	PRICE PROPORTION
All beef (less "all" other beef)	1.12		
Hip cuts (Round steak)	0.25	9.24	$(\frac{0.25}{1.12})*9.24=2.0625$
Loin cuts (Sirloin steak)	0.22	10.06	$(\frac{0.22}{1.12})*10.06=1.9761$
Rib cuts (Prime rib roast)	0.08	9.14	$(\frac{0.08}{1.12})*9.14=0.6529$
Chuck cuts (mean of blade roast)	0.15	5.31	$(\frac{0.15}{1.12})*5.31=0.7113$
Stewing beef	0.05	5.81	$(\frac{0.05}{1.12})*5.81=0.2594$
Ground beef (Hamburger)	0.39	3.30	$(\frac{0.39}{1.12})*3.30=1.1491$
Total (Base period price)			6.8113
Price Calculation	$price = CPI * \frac{6.8113}{100}$		

Source: Handbook of Food Expenditures, Prices and Consumption. (1990). Agriculture Canada Publication 5276/B.

5.3 ADVERTISING OF MEATS

The study involves assessment of the influence of advertising on consumers aggregate purchasing decisions. Advertising and promotion for pork and chicken are carried out at both national and provincial levels. For beef, a national agency advertises and promotes beef consumption on a national level. Actual expenditures on advertising and promotion by the various national and provincial producer organizations are taken as a proxy for the advertising information variable. Advertising and promotion expenditure data were obtained from various sources:

(a) The Generic Advertising and Promotion Program (GAPP) at University of Guelph, Ontario provided national quarterly data for beef from 1982.1 to 1992.2; pork from 1986.1 to 1993.4; and chicken from 1980.1 to 1993.4. They also provided provincial quarterly data on pork for Ontario from 1968.1 to 1993.4. These quarterly data series were calculated from data on annual expenditures on advertising and promotion.

(b) The Quebec Federation of Pork Producers provided data on annual expenditures on pork advertising and promotion in Quebec from 1979 to 1993. These were obtained from the 1979 to 1993 issues of the annual reports of this organization. In personal discussion, representatives of the Federation provided explanations of their expenditure patterns from 1979 to 1993.

(c) The Alberta Pork Development Corporation provided annual data on advertising and promotion expenditure in Alberta from 1977 to 1993. These figures were also available in the 1977 to 1993 issues of their annual reports.

(d) The Albert Chicken Marketing Agency also provided annual expenditure figures on advertising and promotion of chicken in Alberta from 1969 to 1993.

The financial statements in the annual reports of the various producer groups were generally the source of annual expenditure figures on advertising and promotion. The annual figures were disaggregated into monthly data based on the spread of advertising and promotion activities throughout each year. Summation was then made over a three month period in each year to obtain quarterly data series on advertising and promotion. For example, GAPP calculated quarterly data series on beef advertising and promotion based on information provided by the Beef Information Centre (a division of the Canadian Cattlemen's Association with a mandate relating to promotion). The Centre reported that television advertising starts on the air in late September and runs in flights over a nine-month period until May of the following year. Any reported annual expenditure on television advertising in a year was therefore divided equally over nine months from September of that year through May of the following year. This implies that there was no expenditure on television advertising allocated for the summer period i.e. from June to August. The area of coverage for television advertising of beef includes Halifax, Toronto, Kitchener, London, Montreal, Quebec city, Ottawa, Winnipeg, Regina, Saskatoon, Edmonton, Calgary and Vancouver. It was also reported that magazine advertising for beef was usually scheduled to run for a ten-month period from November through August of the following year so that in a particular year, any reported total expenditure on magazine advertising was distributed over ten months, from November of that year to August of the following year. Print expenditure allocation per month was also based on the period of issue for each magazine and the number of pages the advertisement occupy. Magazines usually used include *Canadian Living, Chatelaine, Homemakers, Reader's Digest, Select Homes and Foods, and T.V. Guide.* Reported expenditures on other promotional activities which appeared to be year round were distributed equally over the twelve months in the year. By adding these monthly data series over successive three-month-periods in each year, quarterly data series on beef advertising and promotion were obtained from 1982 to 1993. GAPP also constructed quarterly data series on national and Ontario pork advertising and promotion in a similar fashion.

The same procedure was followed in this study to disaggregate the other annual data series into quarterly estimates. For example, in Quebec, The Federation of Pork Producers reported that prints of recipes and other promotional flyers were distributed to major grocery shops and also made available to the public throughout the year. The reported total expenditure on recipes and flyers in any year was therefore distributed equally among the twelve months in the year. The Federation also reported that monthly information sessions were held at the major grocery shops to educate consumers on the various recipes for pork and so expenditures on the information sessions were also shared equally over the year. However, between September and March they reported that the information sessions included cooking demonstrations, so expenditure on demonstrations was allocated to the months of September through March of the following year. Pork advertising on television and radio was conducted to cover a three-month period from May to July in each year. Accordingly, expenditures on television and radio advertising in each year were distributed equally over three months from May to July. In some years, however, promotion activities could not be identified to have taken place in a particular period within the year, hence the reported total expenditure in the year was distributed evenly throughout the year among the twelve months. This "even spread" assumption regarding the allocation of annual expenditures of advertising and promotion was applied to data from Canadian Chicken Marketing Agency from 1980 to 1993, and Alberta Chicken Marketing Agency from 1969 to 1993. Quarterly aggregation was then done to obtain the estimated data series.

The rationale [illegible] total annual expenditures over the months during which the advertising or t[illegible] activity occurred is that this allows advertising and promotion expenditu[illegible] the period consumers received information on the advertised commodity. Advertising expenditure is being used as a proxy for the advertising publicity variable. It is acknowledged that this may be a second best method to obtain quarterly data series on advertising publicity.

In summary, beef advertising expenditures were obtained from GAPP for the period 1982.1 to 1993.4; data on pork expenditures were made up of expenditure figures from GAPP on the national level from 1986.1 to 1993.4 and Ontario expenditure on advertising and promotion from 1968.1 to 1993.4 as well as expenditure figures from pork producers' associations in Quebec (1984.1 to 1993.4) and Alberta (1977.1 to 1993.4); data on chicken advertising and promotion were obtained from the Canadian Chicken Marketing Agency (1980.1 to 1993.4) and Alberta Chicken Marketing Agency (1969.1 to 1993.4). Though there were some data on expenditures on advertising and promotion in Saskatchewan and Manitoba, these were excluded because the data period was inadequate, from 1989 to

1991. Moreover expenditures involved were minimal. No data was available from other provinces.

Since the time series data on advertising are in nominal values, another data requirement was for a price index needed to deflate these nominal advertising expenditures into real numbers. Advertising and promotion are considered as services and therefore a services consumer price index, (excluding shelter services) was used (CANSIM matrix # P 484494).

5.4 AN INDEX OF HEALTH CONCERNS

To incorporate health concerns some form of attitudinal variables or information about health and nutrition is required. To evaluate the impact of scientific information on consumer perception, a "cholesterol information index" was constructed by Dr. Deborah J. Brown and Dr. Lee F. Schrader of Purdue University, for their study of cholesterol information and shell egg consumption (Brown and Schrader 1990). This index was constructed by scanning all articles in English dealing with humans and with clinical implications listed on the Medline data base. Medline is operated by Dialog Information Services in the United States. The data base includes materials from approximately 3,200 journals published in over seventy countries. It contains over four million citations for 1966 to 1987. It does not include articles prior to 1966. Approximately 520,000 human, English, clinical articles are contained in the Medline data base. These were scanned for any connection with cholesterol. Approximately 8,000 of these articles dealt with cholesterol. Brown and Schrader considered many of these articles to be irrelevant because they focused on smoking, obesity, alcohol abuse, or linked cholesterol with eye, joint, skin, or gall bladder disease. Of the 8,000 titles, those which did not appear relevant to the links between diet cholesterol, serum cholesterol, and heart disease or arteriosclerosis were discarded. In cases where the content was unclear from the title, the decision to include the article was based on a review of the article's abstract. Approximately 1,000 such abstracts were consulted. From the relevant articles among the 8,000 titles read, the numbers of articles supporting and attacking the linkage between cholesterol and heart disease were calculated by quarter. A running total, lagged two quarters, was then calculated, with each article supporting the link (negative information) adding one unit to the total and each article attacking the link (positive information) subtracting one unit from the total. In effect, a simple sum, lagged two quarters, was used as the cholesterol index. The original data series was subsequently updated from the third quarter of 1987 to the fourth quarter of 1991 by Dr. Dong-Kyoon and Dr. Wen S. Chern, of the Ohio State University. The length of this data series limited the ending point of the observations for this study. This and the other data series are provided in Appendix C.

5.5 ESTIMATION PROCEDURE

To estimate the models described in Chapter 4 with data on Canadian meat groups, an error term must be added to each equation in both systems. Since the adding-up condition results in an exact linear combination of the regressors, the variance-covariance matrix for the complete *n*-good system is singular. Thus, one of the *n* equations had to be deleted from the system for purposes of estimation. However, estimates are invariant as to which equation is deleted since the maximum likelihood estimator is used. The seemingly unrelated regressions procedure of SHAZAM program 7.0 (White et al. 1993) was used for estimation.

Various tests are carried out to examine the impact of advertising on meat consumption:

1) The null and alternate hypotheses outlined in Chapter 4 are examined.
2) Models I, II and III are nested. Similarly, models V and VI are nested. As a result, likelihood ratio tests are used to test the null hypothesis.

3) Joint tests on all advertising variables are carried out to assess their collective significance.

4) A non-nested test is also conducted following the procedure outlined in section 4.5

CHAPTER 6

RESULTS, DISCUSSION AND CONCLUSIONS

6.1 INTRODUCTION

This chapter presents the results obtained from the three functional forms used, namely the single equation approach and the LA/AIDS and the Rotterdam models system approaches. Estimates of the coefficients and elasticities are presented in Tables 6.1 to 6.7. Results of other tests as outlined in section 5.5 are also presented. These results are discussed in the next section and some conclusions drawn. The shortcomings of this study are also pointed out and suggestions for further research are made in the final section.

6.2 ESTIMATED COEFFICIENTS AND HYPOTHESIS TESTS

There are prior beliefs about the values of numbers of the coefficients shown in Tables 6.1 to 6.7. There is also an expectation that these should be statistically significant if the postulated explanatory variables are important determinants of meat consumption in Canada. The effects of some of the explanatory variables are better understood in terms of elasticities. The formulae for calculating these elasticities are presented in Appendix B. Table 6.7 presents elasticity estimates of LA/AIDS and Rotterdam models. The single equation specifications are in log-log functional form, giving these estimated coefficients as elasticities. There is some amount of variability in estimated elasticities across model specifications.

6.2.1 Results From Single-Equation Models

The iterative seemingly unrelated regression (SUR) procedure was used in the estimation process. Results of the log likelihood ratio tests are presented in Table 6.8. Results indicate that the unrestricted models where advertising expenditures are included cannot be rejected. Overall, the single-equation models did not perform well as did the system models in terms of sign and significance of the estimated coefficients. Estimated own-price elasticities are generally negative as expected except with the beef specifications where three out of the six estimates are positive. None of these, however is statistically significant. For pork and chicken, all own-price elasticity estimates are negative and most are statistically significant. In Model II, where advertising expenditures are incorporated as independent shifters, own-price elasticities for beef, pork and chicken are respectively 0.057, - 0.466 and -0.358. Goddard and Griffith, using similar linear specifications, obtained -0.48, - 0.30 and -0.54 as the own-price elasticity estimates for beef, pork and chicken respectively. Cross-price effects from the single-equation approach are mixed, nevertheless beef consistently appears to be a substitute in both pork and chicken specifications and most estimates are statistically significant.

One issue is whether the inclusion of advertising allowing for cross-commodity advertising effects influences the size of estimates of the own-price elasticities. Studies on structural change in meat consumption indicate that meat has become less price elastic since the mid 1970s. It is of some interest as to whether advertising campaigns may have affected this situation. This is less readily tested in a single-equation format. Comparison of the single-equation versions of Model I with Models II, III and IV reveal that for beef, estimated values of own-price effects increase quite significantly when advertising impacts are modelled to affect consumption directly although own-price advertising effects are not significant. However, for pork and chicken, when advertising impacts are modelled to affect consumption directly, estimated own-price elasticities decline and are statistically significant. Another notable example of changes in elasticities is evidenced in the variability in income elasticities. For chicken, the inclusion of advertising variables reduces the income elasticity estimates and renders them statistically insignificant irrespective of how advertising effects are modelled. For beef and pork, estimated expenditure elasticity values increase in size and are all significant where advertising effects are modelled to affect consumption directly. Based on the hypothesis that advertising should be modelled in the form of a "scaling" effect, all income elasticities are insignificant and mostly negative. These types of effects on changes in estimates of elasticities were also experienced by Goddard and Griffith (1993). Estimated cholesterol elasticities are mainly statistically insignificant. These are consistently negative for beef.

Regarding the effectiveness of advertising in the single-equation models, only chicken advertising is consistently positive and statistically significant as expected. In Model VI, however, advertising elasticities for pork and beef are negative and statistically significant. Generally, beef and pork advertising are found not to have affected demand in the single-equation approach. A joint-test, to assess the effect of all advertising variables together on consumption of each meat type, reveals that advertising is significant in the chicken specification (Table 6.9).

6.2.2 Results From The Flexible Functional Form Demand System Models.

As stated in section 5.5, Models I, II, and III are nested as are Models V and VI. The likelihood ratio test is a general procedure for testing nested hypothesis when both the restricted and unrestricted models have been estimated by maximum likelihood methods. Results from testing the two groups of nested models are presented in Table 6.8. From the results, we reject the null hypothesis that advertising has zero effects on consumption. Moreover, inclusion of advertising variables in the models can be seen to improve the goodness-of-fit measure (R^2) of individual equations as well as the Durbin Watson statistics.

Tables 6.1 to 6.6 presents estimates of coefficients obtained for these functional forms while Table 6.7 shows the results of estimated elasticities. Generally, seasonality is highly significant in all the models. While beef and chicken show increased consumption with the seasons, pork consumption consistently decline with the various seasons.

Evidently meat consumption generally follows some seasonal pattern. Regarding price elasticities, own-price elasticities from the LA/AIDS model specifications are consistently negative and significant. Cross-price elasticities for beef and pork are consistently negative and significant implying that for beef and pork, the three meat types are gross complements. For chicken, however, where advertising is incorporated to have direct effects on consumption, beef and pork appear as gross complements, otherwise, they are found to be gross substitutes. Where advertising is modelled as having a "scaling" effect, both beef and pork appear as gross complements other than substitutes. Similar results were also obtained by Goddard and Griffith. With the Rotterdam specifications, own-price elasticities for beef have the expected negative sign but none of the estimates are statistically significant. For pork and chicken, own-price elasticities are negative and statistically significant. Generally, the various meat types appear in each specification as gross substitutes and not gross complements, though most of the estimates are statistically insignificant.

Regarding the effect of incorporating advertising on the size of price elasticity estimates, the results of the various LA/AIDS model specifications show that variation in price elasticities differs with each meat type and the way advertising is incorporated into the models. For beef, own-price elasticities increase whether advertising is incorporated to have a direct effect on consumption or an effect through the price (scaling effect). For pork, the effect varies and is not very pronounced. However, for chicken, own price elasticities decline if advertising is modelled as having a direct effect on consumption but increase when advertising is incorporated through the scaling effect. Results from the Rotterdam specifications are quite different. For both beef and chicken, irrespective of the method of incorporating advertising, own-price elasticity estimates increase. Thus for beef, and generally for chicken, when advertising is incorporated into the demand system, own-price elasticity increases with advertising to the point that a one percent fall in price would result in a more than one percent increase in consumption. In Model V of the LA/AIDS specification, where advertising expenditures are used as price deflators, own-price elasticities for all 3 meat types are significantly increased and near unit elasticity.

All expenditure elasticities in both LA/AIDS and Rotterdam specifications are positive and statistically significant. In the Rotterdam specification, incorporating advertising generally increases expenditure elasticities. In the LA/AIDS specifications, expenditure elasticities vary with the method of incorporating advertising. Modelling a direct effect of advertising results in a decline in expenditure elasticity estimates. With advertising modelled to act through prices, expenditure elasticities increase.

Estimates of the advertising elasticities vary but appear to be more consistent with expectations when demand is modelled as the LA/AIDS system rather than as the Rotterdam model. Out of the 36 estimated elasticities, test statistics from SHAZAM indicate that only two of these are statistically significant in the Rotterdam specification. With the LA/AIDS model specification, chicken own-advertising is found to have had a consistent positive effect on demand. In Model VI, where advertising is considered to have both a "scaling" effect and a direct effect, chicken advertising increases chicken demand and at the same time decreases demand for competing products. The joint-test that concurrent advertising by the various producers' groups affects consumption of each meat type is reported in Table 6.9. Results reveal that collectively, advertising has a significant effect on the demand for all the meat types. Even in Model II, where individual advertising coefficients generally have low significance, joint-tests show that advertising activities for all three meat types are significant in their effect on demand. Since the low level of significance could be a symptom of collinearity among the explanatory variables, a measure of collinearity was undertaken. Table 6.10 shows the details of the variance decomposition. From the Durbin-Watson statistics, however, autocorrelation does not appear to be a problem in the model specifications with advertising.

Non-nested tests were conducted to give pair-wise comparisons between the LA/AIDS and Rotterdam systems. The results were in favour of the LA/AIDS model. This set of results can be summarized as follows:

Model 1: All specifications in the LA/AIDS rejected the Rotterdam specifications but the Rotterdam specifications did not reject the LA/AIDS specifications.

Model 2: All LA/AIDS specifications rejected the Rotterdam specifications but not vice versa.

Model 3: All LA/AIDS specifications rejected the Rotterdam specifications but not vice versa.

Model 4: The beef specification of LA/AIDS did not reject the Rotterdam specification. The Rotterdam specifications also did not reject the LA/AIDS in the three meat specifications.

Model 5: All LA/AIDS specifications rejected the Rotterdam specifications but not vice versa.

Model 6: The beef specification in LA/AIDS did not reject the Rotterdam specification. The Rotterdam specifications also did not reject the LA/AIDS in all three meat specifications.

6.3 CONCLUSIONS

Various models of Canadian demand for meat that incorporate both advertising and a measure of cholesterol information have been estimated and compared. The hypothesis that advertising publicity and cholesterol information does not influence Canadian demand for meats is rejected by likelihood ratio tests. However, estimates obtained vary by meat type. The LA/AIDS model is found to explain the data better than the Rotterdam model and, as such, the results obtained from the various specifications of the LA/AIDS model are most worthy of note. Although the results of the single equation models are not greatly different from those estimated by the Rotterdam system model, the individual equation approach is less preferred; it is less consistent with theory; and gives poorer results than the LA/AIDS system model.

The conclusion that advertising of meats has some influence on aggregate meat consumption is supported by the estimates of the effects of advertising on meat demand. In previous studies of the impact of advertising on Canadian meat consumption, cholesterol information has been excluded and results obtained from those studies have been inconsistent and anomalous. In contrast, the results obtained in this study indicate that advertising has had the general effects on meat consumption that are consistent with economic theory and *a priori* expectations though the effects are not as pronounced as that of own-price and income. This suggests that models used in previous studies that did not account for cholesterol information may have been mispecified.

Advertising elasticity estimates are sensitive to the method of incorporating advertising into traditional demand models. Incorporating advertising as a modification of marginal utilities where advertising acts as a deflator of the real prices gives statistically significant results. With own-advertising expenditures as price deflators, all own-price elasticities are significantly increased. Moreover, advertising of each of the meat types is found to have increased demand as well as decreased demand for competing commodities. Such estimates are essential to the determination of how much the industry should be spending on advertising. Since advertising of each of the meat types was found to have increased demand as well as decreased demand for competing commodities, issues of strategic decision making as to optimal expenditures on advertising by all groups may be of interest to producers' groups and are suggested as a topic for further study.

In both the LA/AIDS and Rotterdam specifications, beef and chicken own-price elasticities increased with the incorporation of advertising. It may be that these observed effects are associated with advertising and promotion campaigns by these groups seeking to extend the range of end-uses or type of satisfaction provided by the meat and thus increasing the possibility of substitution for other products (Quilkey 1986). This potential conclusion may be strengthened by the observation that incorporating advertising to have a direct effect on consumption generally gave statistically insignificant estimates. However, tests of the joint effects of meat advertising showed advertising was significant. This suggests only a weak direct effect of own-advertising on consumption.

Estimates of the coefficients for prices, income and seasonality are also consistent with expectations and are seen to account for most of the changes in meat consumption. Prices and incomes are relatively more significant in explaining consumption of meats than advertising or cholesterol information and as such are the most important factors in determining the consumption of meats.

6.4 SHORTCOMINGS OF THE STUDY

One shortcoming of this study concerns the quality of the advertising data. All the producer groups provided actual annual expenditures with some guidelines as to how the annual data could be disaggregated into quarterly data. Moreover Ontario, Quebec and Alberta advertising expenditure data were the only provincial data obtained in addition to national expenditure data. Manitoba and Saskatchewan producers are also known to be engaged in generic advertising of pork and chicken but data from these provinces were unavailable. The disaggregation of annual data into quarterly series may not have reflected actual quarterly expenditure. Moreover, exclusion of turkey, lamb, mutton and fish potentially could affect results since turkey in particular is periodically advertised, though at much lower expenditure levels than other meats.

6.5 SUGGESTIONS FOR FURTHER RESEARCH

An important area to improve is the quality of advertising data. This would be helpful for improving future parametric studies of the effects of advertising on demand. Further consideration of the methods of incorporating advertising including the direct effect on demand, through scaling and translating is also recommended.

The cholesterol information index that was used was an index constructed from American, European and Canadian medical journals; this was available to 1991. Using such an index to represent Canadian consumer behaviour may not be appropriate since consumer response to health issues might vary with these countries. Moreover, there may have been changes in consumer attitudes to health issues since 1991 which need to be accounted for. Therefore, an index which represents typical Canadian behaviour towards health issues in the diet should be pursued and the series extended to accommodate possible changes to consumer behaviour. Such series are expected to be useful in Canadian food demand studies. Finally, extension of the analysis reported here to estimation of optimum advertising activities for producers' groups is an obvious and important priority for further research in this area.

Table 6.1
Estimated Coefficients of Model I[a] (without advertising)

Parameters[d]	LA/AIDS		ROTTERDAM		LINEAR	
Constant						
α_b	0.449	(1.72)	0.001	(0.07)	0.328	(9.26)
α_p	0.05	(0.21)	0.002	(0.20)	0.124	(3.05)
α_c	0.497	(3.07)	-.003	(-.35)	-.789	(-24.04)
Quarters						
λ_{b1}	-.005	(-1.51)	-.004	(-1.54)	-.009	(-.68)
λ_{b2}	0.018	(4.67)	0.016	(4.05)	0.053	(3.84)
λ_{b3}	0.022	(5.55)	0.019	(5.96)	0.070	(5.24)
λ_{p1}	-.004	(-1.30)	-.004	(-1.21)	-.010	(-.708)
λ_{p2}	-.033	(-9.15)	-.030	(-7.69)	-.101	(-6.38)
λ_{p3}	-.034	(-8.89)	-.030	(-7.74)	-.096	(-.622)
λ_{c1}	0.01	(4.49)	0.008	(3.47)	0.055	(4.66)
λ_{c2}	0.016	(6.68)	0.015	(4.66)	0.075	(5.88)
λ_{c3}	0.013	(5.16)	0.010	(3.64)	0.065	(5.23)
Time						
σ_b	-.002	(-13.64)	-.0001	(-.21)	-.005	(-8.40)
σ_p	-.0001	(-.65)	-.0001	(-.18)	-.001	(-1.14)
σ_c	0.002	(22.39)	0.0001	(0.48)	0.011	(21.14)
Price						
γ_{bb}	0.172	(5.58)	-.049	(-.97)	0.026	(0.20)
γ_{bp}	-.105	(-4.77)	0.064	(1.60)	-.051	(-.58)
γ_{bc}	-.067	(-3.63)	-.015	(-.41)	0.025	(0.26)
γ_{pb}	-.105	(-4.77)	0.064	(1.60)	0.358	(2.38)
γ_{pp}	0.126	(5.79)	-.128	(-2.65)	-.489	(-4.9)
γ_{pc}	-.02	(-1.73)	0.064	(2.00)	0.141	(1.26)
γ_{cb}	-.067	(-3.63)	-.015	(-.41)	0.493	(4.07)
γ_{cp}	-.021	(-1.73)	0.064	(2.00)	-.039	(-.48)
γ_{cc}	0.089	(5.56)	-.050	(-1.27)	-.454	(-5.06)

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continuation of Table 6.1

Cholesterol						
τ_b	0.033	(0.62)	-.011	(-.[illegible])	-1.62	(-2.45)
τ_p	0.028	(0.53)	-.060	(-[illegible]31)	-1.29	(-1.63)
τ_c	-.061	(-1.90)	0.071	(5.27)	0.853	(1.35)
Expenditure						
β_b	0.04	(0.71)	0.618	(11.56)	0.398	(2.47)
β_p	0.059	(1.07)	0.275	(4.44)	0.711	(3.84)
β_c	-.099	(-2.83)	0.107	(2.27)	0.620	(4.152)
R_b^2	0.95		0.95		0.91	
R_p^2	0.85		0.78		0.79	
R_c^2	0.98		0.70		0.96	
$D\text{-}W_b$	1.50		2.47		1.64	
$D\text{-}W_p$	1.68		4.49		1.33	
$D\text{-}W_c$	1.25		1.59		1.17	

a t-values are in parenthesis.

d parameters are as defined in chapter 5; R^2_i and $D\text{-}W_i$ represent R-squared value and Durbin Watson statistic respectively, where subscripts of all parameters represent the meat type ie. b = beef, p = pork, and c = chicken

Table 6.2
Estimated Coefficients of Model II[a] (direct effect of advertising as an intercept shifter)

Parameters[d]	LA/AIDS		ROTTERDAM		LINEAR	
Constant						
α_b	0.294	(1.13)	-.001	(-.11)	-11.67	(-1.83)
α_p	-.005	(-.02)	-.003	(-.23)	-12.48	(-1.65)
α_c	0.71	(4.70)	0.004	(0.59)	-1.168	(-.24)
Quarters						
λ_{b1}	0.0003	(0.08)	-.0001	(-.03)	0.014	(0.75)
λ_{b2}	0.002	(1.96)	0.015	(2.99)	0.049	(2.46)
λ_{b3}	0.001	(2.39)	0.019	(3.36)	0.059	(2.76)
λ_{p1}	-.011	(-2.51)	-.005	(-1.01)	-.026	(-1.23)
λ_{p2}	-.026	(-4.18)	-.033	(-6.12)	-.083	(-3.52)
λ_{p3}	-.027	(-4.19)	-.032	(-5.23)	-.085	(-3.36)
λ_{c1}	0.01	(4.53)	0.005	(1.90)	0.033	(2.33)
λ_{c2}	0.014	(3.89)	0.017	(5.48)	0.087	(5.68)
λ_{c3}	0.012	(3.33)	0.013	(3.90)	0.086	(5.25)
Time						
σ_b	-.006	(-1.36)	0.00001	(0.01)	0.028	(1.61)
σ_p	-.001	(-.80)	0.0001	(0.29)	0.035	(1.72)
σ_c	0.003	(3.71)	-.0001	(-.54)	0.009	(0.66)
Advertising						
δ_{bb}	-.006	(-.80)	0.0009	(0.17)	0.006	(0.28)
δ_{bp}	0.01	(1.52)	0.008	(1.16)	0.019	(0.72)
δ_{bc}	-.007	(-2.66)	0.00004	(0.01)	-.005	(-.37)
δ_{pb}	0.007	(0.93)	-.0004	(-.06)	0.015	(0.61)
δ_{pp}	-.015	(-2.25)	-.002	(-.30)	-.057	(-1.85)
δ_{pc}	0.003	(0.93)	-.004	(-.44)	-.003	(-.19)
δ_{cb}	-.001	(-.26)	-.0006	(-.17)	0.014	(0.87)
δ_{cp}	0.005	(1.39)	-.006	(-1.39)	-.007	(-.33)
δ_{cc}	0.005	(2.97)	0.004	(0.79)	0.044	(4.31)

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continuation of Table 6.2

Cholesterol						
τ_b	-.008	(-.15)	-.024	(-.48)	-1.425	(-1.88)
τ_p	0.045	(0.85)	-.037	(-.68)	-1.483	(-1.65)
τ_c	-.037	(-1.21)	0.062	(2.04)	-.079	(-.13)
Price						
γ_{bb}	0.159	(5.09)	-.075	(-1.42)	0.057	(0.42)
γ_{bp}	-.099	(-4.36)	0.060	(1.36)	0.008	(0.09)
γ_{bc}	-.06	(-3.35)	0.014	(0.47)	-.065	(-.60)
γ_{pb}	-.099	(-4.36)	0.060	(1.36)	0.469	(2.91)
γ_{pp}	0.130	(5.65)	-.100	(-2.02)	-.466	(-4.37)
γ_{pc}	-.030	(-2.59)	0.040	(1.56)	-.003	(-.02)
γ_{cb}	-.060	(-3.35)	0.014	(0.47)	0.362	(3.45)
γ_{cp}	-.030	(-2.59)	0.040	(1.56)	-.005	(-.07)
γ_{cc}	0.090	(6.30)	-.054	(-2.82)	-.358	(-4.25)
Expenditure						
β_b	0.070	(1.22)	0.581	(9.69)	0.729	(2.91)
β_p	0.076	(1.27)	0.309	(4.78)	1.177	(3.98)
β_c	-.146	(-4.37)	0.120	(3.02)	0.198	(1.03)
R^2_b	0.96		0.95		0.93	
R^2_p	0.88		0.82		0.82	
R^2_c	0.99		0.86		0.98	
D-W$_b$	2.03		2.72		1.57	
D-W$_p$	2.17		2.62		1.67	
D-W$_c$	2.01		2.26		1.90	

a t-values are in parenthesis.

d parameters are as defined in chapter 5; R^2_i and D-W$_i$ represent R-squared value and Durbin Watson statistic respectively, where subscripts of all parameters represent the meat type ie. b = beef, p = pork, and c = chicken

Table 6.3

Estimated Coefficients of Model III[a] (advertising exhibiting seasonality and having a direct effect as an intercept shifter)

Parameters[d]	LA/AIDS		ROTTERDAM		LINEAR	
Constant						
α_b	0.179	(0.59)	-.003	(-.29)	-9.025	(-1.39)
α_p	0.144	(0.46)	0.0002	(0.02)	-8.086	(-1.03)
α_c	0.676	(4.03)	0.003	(0.47)	-1.550	(-.30)
Quarters						
λ_{b1}	0.001	(0.18)	-.004	(-.65)	0.023	(1.06)
λ_{b2}	0.019	(1.22)	0.031	(1.54)	0.050	(2.05)
λ_{b3}	0.020	(1.40)	0.029	(1.68)	0.072	(2.69)
λ_{p1}	-.008	(-1.35)	-.0004	(-.06)	-.009	(-.38)
λ_{p2}	-.025	(-1.67)	-.040	(-2.06)	-.056	(-1.91)
λ_{p3}	-.025	(-1.70)	-.035	(-2.01)	-.046	(-1.41)
λ_{c1}	0.007	(2.17)	0.004	(1.27)	0.028	(1.86)
λ_{c2}	0.006	(0.76)	0.009	(0.87)	0.077	(3.98)
λ_{c3}	0.004	(0.55)	0.006	(0.61)	0.079	(3.69)
Time						
σ_b	-.002	(-1.36)	0.0001	(0.14)	0.021	(1.17)
σ_p	-.001	(-.71)	0.0001	(0.08)	0.023	(1.06)
σ_c	0.0003	(3.71)	-.0001	(-.38)	0.010	(0.72)
Advertising						
θ_{bb}	-.003	(-.32)	0.009	(0.78)	-.053	(-1.15)
θ_{bp}	0.012	(0.98)	0.003	(0.20)	0.030	(0.97)
θ_{bc}	-.007	(-1.88)	0.003	(0.37)	-.011	(-.76)
θ_{pb}	0.003	(0.26)	-.012	(-1.06)	-.023	(-.41)
θ_{pp}	-.007	(-.59)	0.009	(0.70)	-.020	(-.53)
θ_{pc}	0.002	(0.66)	-.005	(-.63)	-.006	(-.35)
θ_{cb}	0.001	(0.12)	0.003	(0.52)	-.004	(-.12)
θ_{cp}	-.005	(-.67)	-.012	(-1.61)	-.012	(-.75)
θ_{cc}	0.004	(2.20)	0.002	(0.49)	0.040	(3.60)
ϕ_{bb}	-.12	(-.93)	-.011	(-.99)	0.022	(0.82)
ϕ_{bp}	0.015	(1.56)	0.011	(0.95)	-.011	(-.24)

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ϕ_{bc}	-.01	(-2.27)	-.002	(-.24)	0.011	(0.66)
ϕ_{pb}	0.018	(1.30)	0.015	(1.30)	0.051	(1.56)
ϕ_{pp}	-.023	(-2.30)	-.011	(-.88)	-.141	(-2.62)
ϕ_{pc}	0.006	(1.41)	-.003	(-.26)	0.021	(1.06)
ϕ_{cb}	-.005	(-.73)	-.004	(-.60)	0.007	(0.33)
ϕ_{cp}	0.008	(1.44)	-.0006	(-.09)	0.011	(0.30)
ϕ_{cc}	-.004	(1.56)	0.005	(0.89)	0.045	(3.42)
Cholesterol						
τ_b	-.004	(-.07)	0.009	(0.24)	-1.112	(-1.44)
τ_p	0.036	(0.66)	-.065	(-1.60)	-.966	(-1.03)
τ_c	-.032	(-1.05)	0.055	(2.48)	-.122	(-.20)
Price						
γ_{bb}	0.145	(4.01)	-.132	(-1.87)	0.18[illegible]	(1.28)
γ_{bp}	-.032	(-3.57)	0.090	(1.61)	-.074	(-.75)
γ_{bc}	-.053	(-2.64)	0.042	(1.11)	-.113	(-1.00)
γ_{pb}	-.092	(-3.57)	0.090	(1.61)	0.489	(2.77)
γ_{pp}	0.123	(4.89)	-.121	(-2.11)	-.520	(-4.36)
γ_{pc}	-.031	(-2.49)	0.031	(1.10)	0.031	(0.23)
γ_{cb}	-.053	(-2.64)	0.042	(1.11)	0.451	(3.91)
γ_{cp}	-.031	(-2.49)	0.031	(1.10)	.035	(-.45)
γ_{cc}	0.084	(5.54)	-.073	(-2.33)	-.416	(-4.67)
Expenditure						
β_b	0.950	(1.41)	0.647	(9.16)	0.634	(2.47)
β_p	0.043	(0.63)	0.240	(3.28)	0.976	[illegible]4)
β_c	-.138	(-3.74)	0.112	(2.79)	0.229	([illegible]13)
R^2_b	0.97		0.95		0.94	
R^2_p	0.89		0.84		0.84	
R^2_c	0.99		0.88		0.98	
D-W_b	2.03		2.68		1.66	
D-W_p	2.11		2.61		1.61	
D-W_c	2.01		2.40		1.93	

[a] t-values are in parenthesis.

[d] parameters are as defined in chapter 5; R^2_i and D-W_i represent R-squared value and Durbin Watson statistic respectively, where subscripts of all parameters represent the meat type ie. b = beef, p = pork, and c = chicken

Table 6.4

Estimated Coefficients of Model IV[a] ("scaling" effect of advertising but modelled to have a direct effect as an intercept shifter)

Parameters[d]	LA/AIDS		ROTTERDAM		LINEAR	
Constant						
α_b	0.526	(3.35)	-.010	(-.79)	-1.013	(-.16)
α_p	0.292	(1.63)	-.006	(-.48)	2.511	(0.31)
α_c	0.181	(1.56)	0.002	(0.27)	1.973	(0.45)
Quarters						
λ_{b1}	0.003	(0.68)	0.0003	(0.05)	0.012	(0.55)
λ_{b2}	0.016	(3.06)	0.005	(0.73)	0.045	(1.90)
λ_{b3}	0.018	(3.23)	0.008	(1.14)	0.065	(2.64)
λ_{p1}	-.011	(-1.97)	-.004	(-.82)	-.037	(-1.33)
λ_{p2}	-.03	(-5.16)	-.036	(-5.36)	-.080	(-2.65)
λ_{p3}	-.03	(-4.67)	-.034	(-4.51)	-.069	(-2.19)
λ_{c1}	0.008	(2.14)	0.004	(1.80)	0.033	(2.20)
λ_{c2}	0.014	(3.80)	0.014	(4.32)	0.085	(5.21)
λ_{c3}	0.011	(2.86)	0.010	(2.99)	0.087	(5.16)
Time						
σ_b	0.0001	(0.04)	0.0002	(0.89)	-.004	(-.22)
σ_p	-.0002	(-.12)	0.0001	(0.60)	-.007	(-.30)
σ_c	0.0002	(0.13)	-.00001	(-.11)	-.001	(-.08)
Advertising						
δ_{bb}	-.003	(-.46)	0.004	(0.61)	0.008	(0.19)
δ_{bp}	0.012	(1.79)	0.028	(3.48)	-.049	(-1.77)
δ_{bc}	-.01	(-1.42)	0.005	(0.46)	0.005	(0.5)
δ_{pb}	0.001	(0.15)	0.002	(0.25)	-.036	(0.63)
δ_{pp}	-.01	(-1.33)	0.008	(0.96)	0.006	(0.16)
δ_{pc}	0.001	(0.07)	-.002	(-.18)	-.103	(-.89)
δ_{cb}	0.002	(0.40)	0.0003	(0.10)	-.006	(-.18)
δ_{cp}	-.002	(-.39)	-.002	(-.58)	-.001	(-.05)
δ_{cc}	0.01	(1.82)	0.005	(1.05)	-.032	(-.52)
Cholesterol						
τ_b	-.078	(-1.16)	-.132	(-2.19)	-.162	(-.20)
τ_p	0.007	(0.10)	-.085	(-1.37)	0.153	(0.15)
τ_c	0.07	(1.50)	0.040	(1.38)	0.309	(0.56)

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continuation of Table 6.4

Price						
γ_{bb}	0.155	(5.14)	-.124	(-1.77)	-.124	(-.75)
γ_{bp}	-.086	(-3.79)	0.041	(0.87)	0.035	(0.30)
γ_{bc}	-.069	(-3.58)	0.083	(1.51)	0.088	(0.49)
γ_{pb}	-.086	(-3.79)	0.041	(0.87)	0.28	(1.32)
γ_{pp}	0.118	(4.60)	-.128	(-2.41)	-.357	(-2.39)
γ_{pc}	-.032	(-2.16)	0.087	(2.89)	0.079	(0.34)
γ_{cb}	-.069	(-3.58)	0.024	(0.78)	0.302	(2.68)
γ_{cp}	-.032	(-2.16)	0.027	(1.11)	-.005	(-.06)
γ_{cc}	0.101	(5.65)	-.051	(-2.82)	-.297	(-2.40)
Expenditure						
β_b	0.007	(0.28)	0.623	(7.74)	-.0178	(-.14)
β_p	0.006	(0.22)	0.270	(3.27)	0.126	(0.75)
β_c	-.014	(-.71)	0.141	(3.69)	0.022	(-.25)
R^2_b	0.97		0.93		0.90	
R^2_p	0.86		0.78		0.72	
R^2_c	0.93		0.38		0.98	
$D\text{-}W_b$	2.13		2.48		1.83	
$D\text{-}W_p$	1.91		2.52		1.73	
$D\text{-}W_c$	1.71		2.23		2.17	

[a] t-values are in parenthesis.

[d] parameters are as defined in chapter 5; R^2_i and $D\text{-}W_i$ represent R-squared value and Durbin Watson statistic respectively, where subscripts of all parameters represent the meat type ie. b = beef, p = pork, and c = chicken

Table 6.5
Estimated Coefficients of Model V[a] ("scaling" effect of advertising modelled as real price deflator)

Parameters[d]	LA/AIDS		ROTTERDAM		LINEAR	
Constant						
α_b	0.759	(7.40)	-.002	(-.15)	0.377	(0.07)
α_p	0.357	(3.34)	-.003	(-.24)	-6.002	(-.75)
α_c	-.117	(-1.16)	0.002	(0.35)	3.803	(0.91)
Quarters						
λ_{b1}	0.008	(1.30)	-.010	(-2.17)	0.008	(0.40)
λ_{b2}	0.022	(3.31)	0.008	(1.11)	0.039	(1.81)
λ_{b3}	0.017	(2.44)	0.015	(2.05)	0.066	(2.86)
λ_{p1}	-.017	(-2.66)	-.001	(-.27)	-.014	(-.47)
λ_{p2}	-.029	(-4.17)	-.031	(-5.00)	-.081	(-2.44)
λ_{p3}	-.022	(-2.90)	-.035	(-5.33)	-.086	(-2.44)
λ_{c1}	0.009	(2.28)	0.004	(1.94)	0.042	(2.65
λ_{c2}	0.007	(1.66)	0.014	(4.94)	0.089	(5.20)
λ_{c3}	0.005	(0.99)	0.010	(3.37)	0.083	(4.54)
Time						
σ_b	0.001	(0.70)	0.00004	(0.19)	-.008	(-.55)
σ_p	-.002	(-1.46)	0.00007	(0.39)	0.013	(0.64)
σ_c	0.001	(1.15)	-.00002	(-.23)	-.008	(-.74)
Cholesterol						
τ_b	-.135	(-2.15)	-.026	(-.76)	0.028	(0.04)
τ_p	0.088	(1.30)	-.055	(-1.66)	-.740	(-.77)
τ_c	0.048	(1.02)	0.047	(3.17)	0.571	(1.15)
Price						
γ^s_{bb}	0.007	(0.98)	-.003	(-.50)	0.017	(0.82)
γ^s_{bp}	-.007	(-1.17)	-.006	(-1.34)	-.040	(-1.58)
γ^s_{bc}	0.0006	(0.14)	0.009	(1.68)	0.023	(-1.44)
γ^s_{pb}	-.007	(-1.17)	-.006	(-1.34)	0.005	(0.15)
γ^s_{pp}	0.012	(1.69)	-.008	(-1.33)	0.005	(0.13)
γ^s_{pc}	-.006	(-1.24)	0.014	(2.63)	-.010	(-.33)

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continuation of Table 6.5

γ^s_{cb}	0.0006 (0.14)	0.002 (0.67)	0.008 (0.47)
γ^s_{cp}	-.006 (-1.24)	0.003 (1.29)	-.011 (-.56)
γ^s_{cc}	0.005 (1.10)	-.005 (-2.88)	0.003 (0.22)
Expenditure			
β_b	-.043 (-2.04)	0.626 (6.90)	-.041 (-1.44)
β_p	0.005 (0.23)	0.303 (3.44)	-.009 (-.21)
β_c	0.038 (1.92)	0.133 (3.48)	-.081 (-3.65)
R^2_b	0.93	0.90	0.90
R^2_p	0.76	0.71	0.60
R^2_c	0.96	0.86	0.97
$D\text{-}W_b$	1.48	2.17	1.90
$D\text{-}W_p$	1.39	2.63	1.39
$D\text{-}W_c$	0.95	2.16	1.89

a t-values are in parenthesis.

d parameters are as defined in chapter 5; R^2_i and $D\text{-}W_i$ represent R-squared value and Durbin Watson statistic respectively, where subscripts of all parameters represent the meat type ie. b = beef, p = pork, and c = chicken

Table 6.6
Estimated Coefficients of Model VI[a] (advertising as price deflator and as an intercept shifter)

Parameters[d]	LA/AIDS		ROTTERDAM		LINEAR	
Constant						
α_b	0.517	(3.31)	-.007	(-.53)	-.964	(-.15)
α_p	0.307	(1.72)	-.005	(-.39)	2.575	(0.32)
α_c	0.176	(1.52)	0.0002	(0.04)	1.801	(0.41)
Quarters						
λ_{b1}	0.003	(0.68)	-.00001	(-.001)	0.012	(0.55)
λ_{b2}	0.016	(3.06)	0.005	(0.71)	0.045	(1.90)
λ_{b3}	0.018	(3.23)	0.009	(1.20)	0.065	(2.64)
λ_{p1}	-.011	(-1.97)	-.004	(-.83)	-.037	(-1.33)
λ_{p2}	-.030	(-5.16)	-.036	(-5.29)	-.080	(-2.65)
λ_{p3}	-.030	(-4.67)	-.034	(-4.49)	-.069	(-2.19)
λ_{c1}	0.008	(2.14)	0.005	(1.85)	0.033	(2.20)
λ_{c2}	0.014	(3.80)	0.014	(4.24)	0.085	(5.21)
λ_{c3}	0.011	(2.86)	0.010	(2.95)	0.087	(5.16)
Time						
σ_b	0.0001	(0.04)	0.0001	(0.82)	-.004	(-.22)
σ_p	-.0002	(-.12)	0.0001	(0.58)	-.007	(-.30)
σ_c	0.0002	(0.13)	-.00001	(-.06)	-.001	(-.08)
Advertising						
δ_{bb}	0.153	(5.06)	-.106	(-1.52)	-.132	(-.72)
δ_{bp}	-.075	(-3.22)	0.067	(1.38)	0.084	(0.70)
δ_{bc}	-.080	(-3.59)	0.075	(1.40)	0.084	(0.67)
δ_{pb}	-.085	(-3.74)	0.041	(0.85)	0.314	(1.33)
δ_{pp}	0.108	(4.15)	-.120	(-2.18)	-.362	(-2.36)
δ_{pc}	-.031	(-1.63)	0.086	(1.87)	0.182	(1.14)
δ_{cb}	-.067	(-3.44)	0.023	(0.76)	0.308	(2.43)
δ_{cp}	-.033	(-2.23)	0.025	(1.03)	-.004	(-.05)
δ_{cc}	0.111	(5.39)	-.045	(-1.67)	-.265	(-3.09)

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continuation of Table 6.6

Cholesterol						
τ_b	-.078	(-1.16)	-.235	(-2.57)	-.162	(-.20)
τ_p	0.007	(0.10)	-.121	(-1.58)	0.153	(0.15)
τ_c	0.070	(1.50)	0.083	(1.99)	0.309	(0.56)
Prices						
γ^s_{bb}	0.155	(5.14)	-.110	(-1.61)	-.124	(-.75)
γ^s_{bp}	-.086	(-3.79)	0.039	(0.84)	0.035	(0.30)
γ^s_{bc}	-.069	(-3.58)	0.070	(1.33)	0.088	(0.49)
γ^s_{pb}	-.086	(-3.79)	0.039	(0.84)	0.278	(1.32)
γ^s_{pp}	0.118	(4.60)	-.128	(-2.41)	-.357	(-2.39)
γ^s_{pc}	-.032	(2.16)	0.088	(1.96)	0.079	(0.34)
γ^s_{cb}	-.069	(-3.58)	0.023	(0.76)	0.302	(2.68)
γ^s_{cp}	-.032	(-2.16)	0.027	(1.14)	-.005	(-.06)
γ^s_{cc}	0.100	(5.65)	-.050	(-2.89)	-.297	(-2.40)
Expenditure						
β_b	0.007	(0.28)	0.619	(7.65)	-.018	(-.14)
β_p	0.006	(0.22)	0.269	(3.26)	0.126	(0.75)
β_c	0.176	(1.52)	0.143	(3.74)	-.022	(-.25)
R^2_b	0.97		0.93		0.90	
R^2_p	0.86		0.78		0.72	
R^2_c	0.98		0.88		0.98	
$D\text{-}W_b$	2.13		2.47		1.83	
$D\text{-}W_p$	1.91		2.52		1.73	
$D\text{-}W_c$	1.70		2.24		2.17	

[a] t-values are in parenthesis.

[d] parameters are as defined in chapter 5; R^2_i and $D\text{-}W_i$ represent R-squared value and Durbin Watson statistic respectively, where subscripts of all parameters represent the meat type ie. b = beef, p = pork, and c = chicken

Table 6.7
Estimates of Elasticities (LA/AIDS and Rotterdam)*

	Model I		Model II		Model III		Model IV		Model V		Model VI	
	L/AIDS	ROT	L/AIDS	ROT	L/AIDS	ROT	L/AIDS	ROT	L/AIDS	ROT	L/AIDS	ROT
Price												
ϵ_{bb}	-.697*	-.099	-.754*	-.149	-.807*	-.264	-.698*	-.248	-.944*	-.006	-.698*	-.220
ϵ_{bp}	-.233*	0.128	-.241*	0.121	-.241*	0.180	-.176*	0.083	0.012*	-.012	-.176*	0.079
ϵ_{bc}	-.161*	-.029	-.167*	0.029	-.170*	0.084	-.142*	0.166	0.03*	0.019	-.142*	0.141
ϵ_{pb}	-.437*	0.224*	-.447*	0.211*	-.369*	0.315*	-.290*	0.144*	-.032*	-.022	-.290*	0.138*
ϵ_{pp}	-.650*	-.450*	-.655*	-.350*	-.643*	-.424*	-.623*	-.449*	-.963*	-.028*	-.623*	-.448*
ϵ_{pc}	-.135	0.226*	-.183*	0.139	-.150*	0.109	-.110*	0.305*	-.024	0.050*	-.110*	0.309*
ϵ_{cb}	-.051	-.072*	0.040	0.070	0.048	0.207	-.182*	0.118	-.054	0.008	-.182*	0.112
ϵ_{cp}	0.027*	0.318*	0.043*	0.196*	0.033*	0.153*	-.081*	0.131*	-.057*	0.016*	-.081*	0.134*
ϵ_{cc}	-.541*	-.246	-.589*	-.267*	-.615*	-.361*	-.691*	-.250*	-1.02*	-.024*	-.691*	-.246*
Expenditure												
η_b	1.08*	1.238*	1.14*	1.165*	1.189*	1.300*	1.014*	1.248*	0.915*	1.254*	1.014*	1.241*
η_p	1.192*	0.963*	1.246*	1.080*	1.140*	0.840*	1.021*	0.948*	1.020*	1.062*	1.021*	0.944*
η_c	0.71*	0.530*	0.572*	0.545*	0.596*	0.555*	0.961*	0.670*	1.110*	0.655*	0.961*	0.706*
Advertising												
E_{bb}			-.011	0.002	-.030	-.004	0.005	-.008*			0.303*	-.212
E_{bp}			0.019*	0.017	0.055*	0.028	-.023	-.056*			-.148*	0.134
E_{bc}			-.015*	0.00003	-.034*	0.001	0.021	-.009			-.158*	0.150
E_{pb}			0.022*	-.002	0.065*	0.009	-.003	-.006			-.277*	0.144*
E_{pp}			-.048*	-.009	-.101*	-.004	0.032	-.027			0.351*	-.421*
E_{pc}			0.009	-.018	0.029	-.026	-.002	0.007			-.101*	0.303
E_{cb}			-.003	-.002	-.018	-.002	-.005	-.002			-.197*	0.113
E_{cp}			0.015*	-.028	0.010*	-.044	0.005	0.011			-.100*	0.125
E_{cc}			0.014*	0.025	0.024*	0.024	-.029	-.025			0.032*	-.220
Cholesterol												
C_b	0.066	-.022*	-.016	-.049	-.008	0.019	-.155	-.265*	-.269*	-.053	-.155	-.470*
C_p	0.097	-.211*	0.145	-.107*	0.117	-.226*	0.024	-.297	0.284	-.193*	0.024	-.424*
C_c	-.300	0.351*	-.108	0.271*	-.094	0.272*	0.206	0.195	0.139	0.231*	0.206	0.412*

* Denotes significance at 95% level.

Table 6.8
Results of Likelihood Ratio Tests[a]

Model	L_U	L_R	Test Statistic	Number of Restrictions	Critical Value
LA/AIDS					
I & II	319.98	306.73	26.50	9	16.92
I & III	323.01	306.73	32.56	18	28.87
I & IV	319.98	306.72	26.50	9	16.92
V & VI	312.05	285.80	52.50	9	16.92
ROTTERDAM					
I & II	287.10	271.57	31.06	9	16.92
I & III	290.61	271.57	38.08	18	28.87
I & IV	287.10	271.57	31.06	9	16.92
V & VI	255.47	242.01	26.92	9	16.92
LINEAR					
I & II	293.28	272.63	41.30	9	16.92
I & III	301.89	272.63	58.52	18	28.87
I & IV	293.28	272.63	41.30	9	16.92
V & VI	281.23	263.73	35.00	9	19.92

a The likelihood ratio (LR) test is a general procedure for testing nested hypothesis when both the restricted and unrestricted models have been estimated by maximum likelihood methods. The test is based on computing values of the maximised log-likelihood functions for both models. If the unrestricted maximum is close to the restricted maximum, this indicates that the restrictions should be favoured. However, if the difference is substantial, the restrictions are rejected. The LR is given by:

$$g = -2(L_R - L_U)$$

where L_U and L_R are values of the maximised log-likelihood functions for the unrestricted and restricted models respectively. The H_0 to be tested is expressed as:

For Models II, IV and VI: H_0 $\delta_{ij} = 0$
H_1 $\delta_{ij} \neq 0$

For Model III: H_0 θ_{ij} and $\phi_{ij} = 0$
H_1 θ_{ij} and $\phi_{ij} \neq 0$

Under H_0 that the restrictions are true, g has an approximate χ^2-distribution with degrees of freedom equal to the number of restrictions. We reject H_0 if the test statistic (g) is greater than the critical value.

Table 6.9
Results of Joint-tests of Advertising Variables[a]

	F-STATISTIC				WALD χ^2 - STATISTIC			
	LA/AIDS	ROTTERDAM	LINEAR	CRITICAL VALUE	LA/AIDS	ROTTERDAM	LINEAR	CRITICAL VALUE
Model II								
Beef	3.22	0.55	0.35	2.76	9.65	1.64	1.04	7.82
Pork	1.99	0.13	1.14	2.76	5.96	0.38	3.43	7.82
Chicken	3.60	1.41	6.66	2.76	10.80	4.22	19.98	7.82
Model III								
Beef	1.67	0.47	1.05	2.29	10.01	2.80	6.90	12.59
Pork	1.15	0.64	1.22	2.29	6.92	3.84	7.32	12.59
Chicken	2.38	1.01	4.04	2.29	14.28	6.07	24.22	12.59
Model IV								
Beef	1.67	4.50	1.10	2.76	5.00	13.50	3.29	7.82
Pork	0.61	0.46	0.31	2.76	1.82	1.38	0.92	7.82
Chicken	1.29	0.7	0.16	2.76	3.88	2.13	0.48	7.82
Model VI								
Beef	8.89	2.80	0.44	2.76	26.68	8.41	1.32	7.82
Pork	6.02	1.90	4.30	2.76	18.07	5.70	12.89	7.82
Chicken	9.94	1.07	3.52	2.76	29.81	3.20	10.55	7.82

[a] critical value is at 95% confidence level. For the F-statistic, the critical value for the linear specification is slightly lower than the systems specifications. Specifically, the values are 2.72 for Models II, IV, and VI and 2.14 for Model III. We reject the null hypothesis that advertising of the three meat types (collectively) is not significant in affecting demand if the test statistic is greater than the critical value.

Table 6.10
Results of Collinearity Tests for the Variables used in LA/AIDS model III[a]

Variables[b]	1	2	3	4	5	6	7	8	9	10	11	12
Singular Value	2.612	1.584	1.057	1.000	0.495	0.359	0.289	0.221	0.159	0.117	0.038	0.011
Condition Index	1.000	1.649	2.471	2.608	5.278	7.283	9.034	11.819	16.398	22.305	69.333	243.492
Variance Proportion	0.001	0.005	0.137	0.000	0.444	0.001	0.047	0.011	0.120	0.201	0.026	0.007
	0.001	0.001	0.024	0.050	0.114	0.002	0.004	0.010	0.005	0.680	0.093	0.016
	0.001	0.000	0.015	0.073	0.092	0.013	0.001	0.026	0.000	0.636	0.144	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.998
	0.000	0.000	0.001	0.000	0.012	0.002	0.004	0.011	0.069	0.753	0.136	0.012
	0.000	0.000	0.001	0.000	0.001	0.001	0.009	0.002	0.537	0.426	0.009	0.013
	0.001	0.000	0.000	0.000	0.000	0.003	0.775	0.006	0.007	0.007	0.142	0.056
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.115	0.881
	0.000	0.003	0.000	0.001	0.000	0.004	0.015	0.391	0.016	0.032	0.419	0.119
	0.000	0.020	0.000	0.000	0.014	0.519	0.031	0.231	0.001	0.163	0.000	0.021
	0.001	0.007	0.001	0.000	0.002	0.245	0.003	0.353	0.007	0.096	0.255	0.031
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.326	0.670

a The Condition index or number is a means of measuring collinearity among regressors. It is the ratio of the largest Singular value (characteristic root) to each of the singular values. If the explanatory variables are orthogonal the condition index will be one. The greater the intercorrelation among the variables, the higher will be the condition index. Any value in excess of 30 suggests potential problems with the estimates. The variance-decomposition proportions is a matrix of the singular values associated with the regressors. The values in the matrix represent the amount of variance in the estimated coefficients accounted for by the singular values. Where the value is greater than 0.5 in two or more columns, a linear dependence is suspected.

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APPENDIX A

It is possible to decompose the effects of advertising when this is modelled as a deflator of prices. The general assumption is that:

$$Q = f\left(\frac{P}{A}\right) = Q(P, A)$$

(1) $$\frac{\partial Q}{\partial\left(\frac{P}{A}\right)} = \frac{\partial Q}{\partial P} \cdot \frac{\partial P}{\partial\left(\frac{P}{A}\right)} + \frac{\partial Q}{\partial A} \cdot \frac{\partial A}{\partial\left(\frac{P}{A}\right)}$$

Noting that $\dfrac{\partial P}{\partial\left(\frac{P}{A}\right)} = \dfrac{1}{\partial\left(\frac{P}{A}\right)/\partial P}$ and $\dfrac{\partial A}{\partial\left(\frac{P}{A}\right)} = \dfrac{1}{\partial\left(\frac{P}{A}\right)/\partial A}$

and assuming A and P are independent, i.e. $\dfrac{\partial P}{\partial A} = 0$ and $\dfrac{\partial A}{\partial P} = 0$

(2) $$\frac{\partial\left(\frac{P}{A}\right)}{\partial P} = \frac{A\frac{\partial P}{\partial P} - P\frac{\partial A}{\partial P}}{A^2} = \frac{1}{A} \quad \therefore \quad \frac{\partial P}{\partial\left(\frac{P}{A}\right)} = A$$

(3) $$\frac{\partial\left(\frac{P}{A}\right)}{\partial A} = \frac{A\frac{\partial P}{\partial A} - P\frac{\partial A}{\partial A}}{A^2} = -\frac{P}{A^2} \quad \therefore \quad \frac{\partial A}{\partial\left(\frac{P}{A}\right)} = -\frac{A^2}{P}$$

Substituting equations (2) and (3) into (1) gives

(4) $$\frac{\partial Q}{\partial\left(\frac{P}{A}\right)} = \frac{\partial Q}{\partial P} \cdot A + \frac{\partial Q}{\partial A} \cdot \left(-\frac{A^2}{P}\right)$$

and multiplying both sides of equation (4) by $\dfrac{P}{AQ}$ gives

$$\frac{\partial Q}{\partial\left(\frac{P}{A}\right)} \cdot \frac{P/A}{Q} = \frac{\partial Q}{\partial P} \cdot A \cdot \frac{P}{AQ} + \frac{\partial Q}{\partial Q} \cdot -\frac{A^2}{P} \cdot \frac{P}{AQ}$$

(5) $$= \frac{\partial Q}{\partial P} \cdot \frac{P}{Q} - \frac{\partial Q}{\partial A} \cdot \frac{A}{Q}$$

APPENDIX B

Elasticities are calculated as follows:

Price:

AIDS:

$$\epsilon_{ij} = \frac{(\gamma_{ij} - (\beta_i * w_j)}{w_i} - \delta_{ij}$$

ROTTERDAM:

$$\epsilon_{ij} = \frac{\gamma_{ij}}{w_i}$$

where ε_{ij} is the price elasticity of demand for the i^{th} commodity with respect to the j^{th} price, γ_{ij}'s are price coefficients, β_i is the coefficient associated with the expenditure term, w_i is the mean share and $\delta_{ij}=1$ for i=j and $\delta_{ij}=0$ for $i \neq j$.

Expenditure:

AIDS:

$$\eta_i = 1 + \frac{\beta_i}{w_i}$$

ROTTERDAM:

$$\eta_i = \frac{\beta_i}{w_i}$$

where η_i is the expenditure elasticity and others as previously defined.

Advertising (Both AIDS and ROTTERDAM):

Models 2, 4 and 6:

$$E_{ij} = \frac{\delta_{ij}}{w_i}$$

Model 3:

$$E_{ij} = \frac{\theta_{ij} + \phi_{ij}}{w_i}$$

where E_{ij} is the advertising elasticity of demand of the i^{th} commodity with respect to the j^{th} advertising expenditure, δ_{ij}, θ_{ij} and ϕ_{ij} are advertising coefficient estimates.

Cholesterol (Both AIDS and ROTTERDAM):

$$C_i = \frac{\tau_i}{w_i}$$

where C_i is the cholesterol elasticity and τ_i is the coefficient estimates on the cholesterol index.

APPENDIX C

YR	QTR	BQ	PQ	CQ	BP	PP	CP	BADV	PADV	CADV	CHO	NCPI	SCPI
1982	1	7.1	5.91	3.88	5.6781	3.8859	3.4036	591520	111534	7910	575	81.7	78.27
1982	2	7.18	5.31	4.2	6.2956	4.4378	3.2406	262488	252982	7910	588	86.8	80.97
1982	3	7.67	4.84	4.13	6.2979	4.8933	3.31[illegible]9	249640	348084	7910	600	89.5	83.07
1982	4	7.68	5.81	3.83	5.9392	4.7146	3.3129	556329	373800	7910	613	87.5	84.43
1983	1	7.01	5.43	4.04	5.8416	4.7584	3.2351	591520	134536	8914	626	86.3	85.03
1983	2	7.51	5.4	4.3	6.2865	4.4291	3.2861	262487	348380	8914	639	88	86.2
1983	3	7.61	5.51	4.08	6.114	4.3782	3.4853	372958	394885	8914	649	87.6	87.53
1983	4	7.24	5.95	3.76	6.1549	4.168	3.7598	778384	383696	8914	661	88.2	88
1984	1	6.74	5.56	4.29	6.4114	4.1925	3.7764	831226	155380	15533	680	89.9	88.5
1984	2	7.2	5.24	4.5	6.5476	4.2626	3.6768	402437	516203	15533	690	91.3	89.77
1984	3	7.36	5.16	4.45	6.4795	4.6463	3.6142	432341	496303	15533	708	92.7	91.4
1984	4	6.79	5.62	4.23	6.5681	4.5377	3.6028	906261	487162	15533	721	93.3	91.17
1985	1	6.71	5.49	4.6	6.6997	4.5412	3.4585	957520	219299	27287	747	94.3	92.07
1985	2	7.22	5.55	4.72	6.7792	4.38	3.4802	464407	520769	27287	764	93.8	93.6
1985	3	7.73	5.41	4.92	6.6067	4.5622	3.613	398872	556474	27287	778	94	95.07
1985	4	6.67	5.52	4.48	6.5772	4.6165	3.5172	721529	490214	27287	796	93.9	96.07
1986	1	6.49	5.45	4.64	6.7202	4.7707	3.5555	811093	217932	53084	816	95.8	97.27
1986	2	7.26	5.05	5.04	6.5862	4.8057	3.544	426349	538016	53084	828	95.3	99.37
1986	3	7.29	4.89	4.9	6.752	5.6397	3.9998	437131	536176	53084	861	101.8	101.47
1986	4	6.61	5.56	4.68	7.1765	5.8044	4.2258	733433	403434	53084	885	107.1	101.9
1987	1	6.6	5.49	4.93	7.2128	5.5854	4.1083	828173	358564	93313	905	106.1	102.27
1987	2	6.6	4.85	5.24	7.4626	5.6695	4.0547	467198	792560	93313	935	107.1	103.67
1987	3	6.99	5.13	5.4	7.508	6.0129	4.0636	529720	694471	93313	955	109.8	105.8
1987	4	6.24	5.37	4.88	7.5443	5.6274	4.033	965439	471903	93313	983	109.1	105.63
1988	1	6.61	5.43	5.25	7.5035	5.2928	4.0087	1060828	453281	105034	1004	107.5	106.83
1988	2	6.91	4.89	5.5	7.5602	5.3576	4.0062	554554	949843	105034	1018	107.4	108.37
1988	3	6.74	5.4	5.36	7.542	5.6432	4.3356	663062	904008	105034	1030	109.6	109.47
1988	4	6.15	5.59	5.11	7.567	5.482	4.1275	1166743	553244	105034	1054	108.6	110.27
1989	1	5.98	5.62	5.04	7.6169	5.3734	4.3458	1308414	413140	157616	1079	109.5	111.43
1989	2	6.85	5.4	5.45	7.7169	5.4102	4.5066	686224	698343	157617	1103	110.2	113
1989	3	6.7	5.35	5.38	7.7214	5.7045	4.7849	229237	703697	157616	1128	112.7	115.03

YR	QTR	BQ	PQ	CQ	BP	PP	CP	BADV	PADV	CADV	CHO	MCPI	SCPI
1989	4	6.04	5.44	4.97	7.7736	5.659	4.739	1106896	493921	157616	1153	113.5	116.07
1990	1	6.07	5.4	5.23	7.8417	5.6572	4.7747	981157	441667	156007	1176	114.5	117.3
1990	2	6.45	4.88	5.65	8.012	6.0129	4.7964	972532	1296942	156007	1200	117.3	119.23
1990	3	6.46	4.49	5.51	8.037	6.2914	4.8577	512625	1106567	156007	1227	120.3	121.63
1990	4	5.74	5.06	5.19	8.1391	6.1636	4.896	903617	722772	156007	1253	121.3	123.7
1991	1	5.75	5.23	5.19	8.1891	5.9796	4.8769	1417776	682469	76654	1275	121	130.03
1991	2	6.34	4.77	5.58	8.0915	5.864	4.6407	939226	1039095	76654	1307	118.8	131.07
1991	3	6.29	4.8	5.67	8.046	5.9375	4.716	608535	922200	76654	1332	119.1	131.93
1991	4	5.83	5.35	5.06	7.903	5.7658	4.6867	874533	739277	76654	1346	117.3	133.2

Definition of the abbreviations is as follows:
YR = year
QTR = quarters
BQ = per capita consumption of beef (kilos)
PQ = per capita consumption of pork (kilos)
CQ = per capita consumption of chicken (kilos)
BP = beef price
PP = pork price
CP = chicken price
BADV = beef advertising expenditures
PADV = pork advertising expenditures
CADV = chicken advertising expenditures
CHO = cholesterol index
MCPI = meat consumer price index
SCPI = services (excluding shelter) consumer price index