DEMAND ANALYSIS FOR SELECTED AGRICULTURAL COMMODITIES, CANADA, 1926-62

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ABSTRACT

DEMAND ANALYSIS FOR SELECTED

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Elasticity estimates are basic to research in forecasting, production, distribution, decision-making and planning for government policy formulations. The lack of these statistics for the majority of Canadian farm commodities presents a major limitation to progress in demand analysis. It is customary for Canadian investigators and policy makers to rely on elasticities derived in other countries. Such coefficients are not expected to be truly representative of consumer behavior in Canada since demand characteristics may vary from country to country. The present investigation is undertaken with a view to satisfying this deficiency. More specifically, the objectives of the study are to derive price, income and cross elasticities for selected edible agricultural commodities; to cite their implications for Canada and to make forecasts of consumption up to 1970.

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*Omitting the years of World War II (1940-46).

It is hypothesized that functional relationships exist between per capita consumption and real prices and between per capita consumption and disposable income; that there is a functional relationship between the prices of some products and the quantities of some other products purchased.

Rationality and consistency in consumer behavior is assumed. In addition, prices, income, population and purchasing power of the monetary unit are dominant forces in demand determination; the marginal propensity to consume is relatively stable within a given income group and demand is more stable than supply for the commodities analyzed.

Annual data from the Dominion Bureau of Statistics are used in the empirical analysis. Multiple Regression based on Least Squares and the Cobb-Douglas form of function is the main operational technique used in estimating demand functions. Per capita consumption (Q_{it}) is regarded as dependent upon real retail prices (X_{it}), disposable incomes (X_{2t}), real prices of related commodities ($X_{3t} \ldots X_{n-1t}$) and consumers' preference (X_n), where i = 1 . . . n and t represents current time. The basic model is of the form:

$$Q_{it} = \alpha X_{it}^{\beta_1} X_{2t}^{\beta_2} X_{3t}^{\beta_3} \ldots e_t^{\beta_n X_n} \varepsilon \ldots\ldots \text{(i)}$$

where e and α are constants, ε represents true error and the β_i values = elasticities with respect to the respective independent variables. With the qualifying assumptions made, equation (i) is expressed logarithmically as:

$$\log \hat{Q}_{it} = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 X_4 \ldots \text{(ii)}$$

Autocorrelation and Multicollinearity are generally present in time series data. Their combined influences result in indeterminate and biased coefficients. In order to circumvent these disturbing influences the basic model is pre-tested in three variations with a view to selecting the form which gives the most satisfactory results. The variations include the basic form in equation ii, a method of partial First Differences and a method of total First Differences. On basis of the greatly diminished influences of autocorrelation and multicollinearity the method of total First Differences is selected for the entire analysis.

National demand functions are derived for red meats, poultry meats, cereals, dairy products, fats and oils, beverages and sugar, starches and vegetables. Commodities are selected on basis of their prominence in consumers' diets and data availability. Statistical predictions, 1962-70, are based on the demand functions derived and are supported by some qualifying assumptions.

The empirical results show that in most instances increased prices result in significant curtailment of consumption. Consumer demand for margarine (.24) and white potatoes (.21) is highly inelastic and the function is of the unconventional, positively sloping type. Other commodities with highly inelastic demand are butter (-.15), coffee (-.27), tea (-.25), sugar (-.27), wheat flour (-.24), and dairy products as a composite (-.01). Demand is highly elastic for lamb (-1.78) and poultry meat (-1.06) and intermediary for red meats as a composite (-.43), pork (-.66) and cheese (-.71).

Disposable income exerts a significant influence on food consumption in Canada. Pork (-1.43), margarine (-1.09), lard (-1.84), wheat flour (-1.66) and cereal products (-2.33) are in general deemed inferior goods in view of their negative and significant income elasticities.

Economic relationships between certain foods and food groups have not been clearly established. The lack of statistical significance of some coefficients indicates independence between commodities. On the other hand, true relationships have been masked in some instances as indicated by the relatively high standard errors of the regression coefficients.

Predictions show that the greatest proportionate increase in food consumption between 1962-70 is expected in cheese (129%), margarine (122%), coffee (74%), poultry meat (55%) and red meats (42%). During this period significant decreases are expected in total butter and tea consumption. Future economic potential for red meats, poultry products, margarine and cheese is particularly promising. Because of acute competition from the United States it is advisable that the feasibility of expanding output of these commodities be thoroughly evaluated.

There is need for adequate planning and training with a view to developing necessary skills and technology. Government loans, modified trade policies and assured sources of stable supplies (of foods not produced domestically) are desirable ends to which Canada might aspire.

With a view to supporting, refuting or improving the validity of the results presented in this thesis, it is suggested that further

research be undertaken on the topic. These may directed toward (1) the application of a different treatment from that of the present study, viz. family budgeting, ordering or scaling preference methods, (2) pre-testing several independent variable-combinations with a view to analyzing the most casual variables, (3) improving (prior to analysis) the quality of data used, (4) analyses at the micro level to determine the effects of importation of foods (capable of being produced locally) on individual farm firms, (5) research at the macro level aimed at evaluating Canada's potential for output expansion or curtailment in the enterprises suggested.

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CHAPTER I

INTRODUCTION

The proportionate contribution of agriculture to the Gross Domestic Product of Canada has been decreasing over time.[1] Nevertheless, the farming sector remains relatively important to the economy since it comprises an industry on which the various other sectors depend.

Changes at the retail level are usually transmitted to the production stage, and vice versa. Governments and other agencies are constantly being requested to assist in improving or alleviating conditions through planning and controls. The measures taken are most effective when they are formulated and guided by reliable basic parameters derived through empirical research.

The inadequacy of basic parameters (elasticity estimates) imposes a major limitation to progress in empirical demand analysis in Canada. These elasticities are necessary to indicate responsiveness of consumers' behaviour to disturbances in the important determinants of demand. The lack of such estimates render forecasting, planning and decision-making difficult. Investigators and policy makers

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[1] Research and Development Division, National Accounts, Income and Expenditure, 1926-56, Dominion Bureau of Statistics, Ottawa, 1958, pp. 28-29; National Accounts and Balance of Payments Division, National Accounts, Income and Expenditure, 1962, Dominion Bureau of Statistics, Ottawa, 1963, p.23.

have consequently had to rely upon elasticities derived from data in other countries and under conditions external to Canada. There is therefore a definite need for elasticity estimates derived from Canadian data, particularly since demand characteristics may vary from country to country. Consequently, this investigation was undertaken with a view to overcoming the deficiency.

Historical Framework of Income and Consumption Patterns

With the exception of the depression years, real disposable income per capita in Canada increased noticeably between 1926 and 1962 (Figure 1). Percentagewise, the increase in real values approximated 109 per cent (from $552 in 1926 to $1157 in 1962). This was somewhat higher than the increase in population which rose by 96 per cent over the same period (from 9.5 million in 1926 to approximately 18.6 million in 1962). It was therefore not surprising that real personal expenditure on consumer goods and services increased as rapidly as it did (Figure 1). From slightly over five billion dollars in 1926, personal expenditure rose 30 per cent by 1939 and by another 79 per cent between 1947 and 1962.[2] Annual expenditure remained high in the post-war period, with about 19.2 billion dollars spent in 1962.[3]

Of the various categories of consumer expenditures on goods

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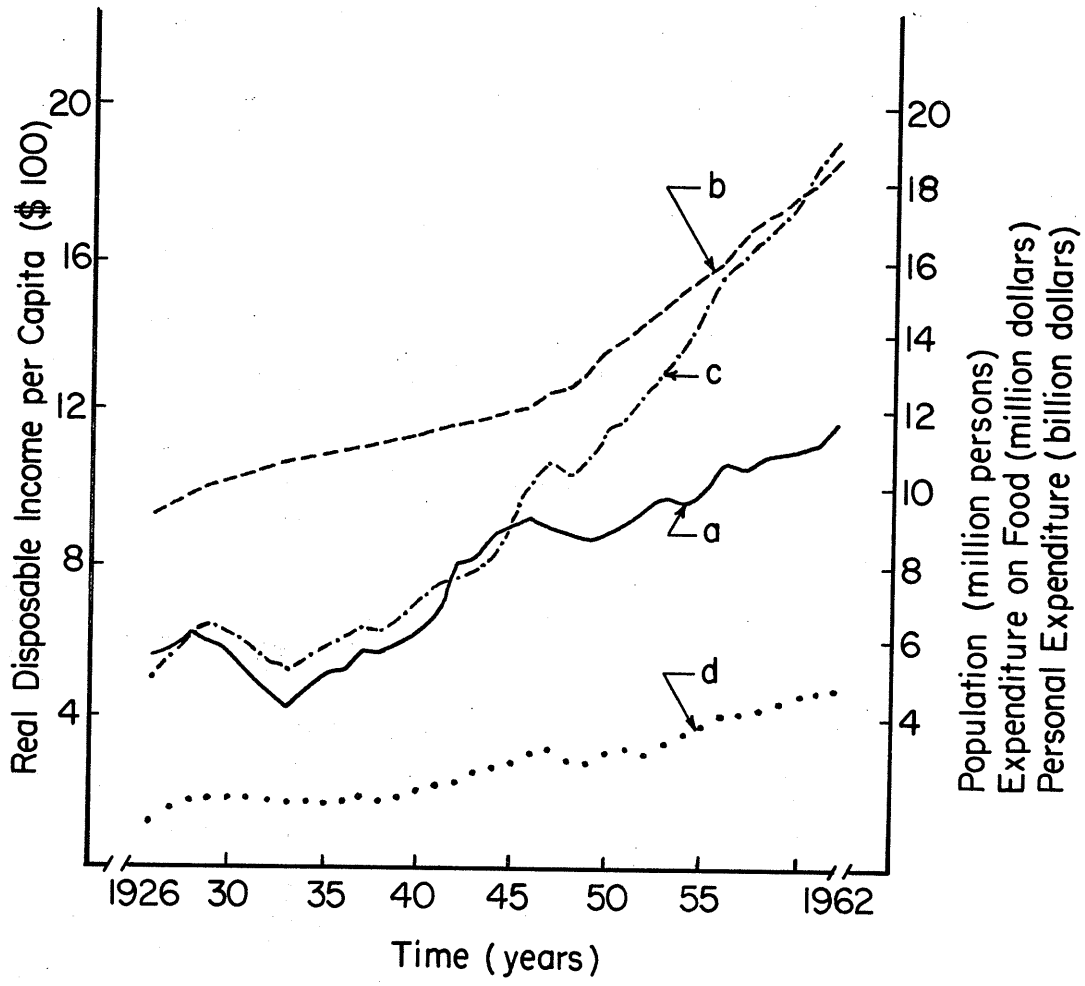
[2] Ibid., pp. 90-91; p.65.

[3] Ibid.



Trends in (a) Real Disposable Income per Capita (b) Population (c) Real Personal Expediture on Goods and Services and (d) Expenditure on Food.

Fig. I

and services, the highest proportion of expenditures was allocated to articles of food (Appendix A). The proportion spent on food between 1926 and 1939 increased from about 27 per cent of personal expenditure in 1926 to a high of 34 per cent in 1933 and declined sharply thereafter.

The situation for the post war period (1947-62) is illustrated in Table I. During 1947-51 real disposable income per capita was about 900 dollars of which approximately 226 dollars or 29 per cent was spent on food. By 1962 these averages were 1,157 and 256 respectively with expenditure on food falling to about 22 per cent of real disposable income. Column 4 of the table illustrates the decreasing trend in proportionate expenditures on foods for the period indicated.

TABLE I

PERSONAL DISPOSABLE INCOME PER CAPITA AND PERSONAL EXPENDITURE ON FOOD, CANADA, 1947-62*
(Dollars and per cent)

Period (1)	Real Disposable Income Per Capita (2)	Per Capita Expenditure On Food (3)	Per Cent (3) of (2)
1947-51	900	226	29
1952-56	991	237	24
1957-61	1,077	255	23
1962	1,157	256	22

* Source: Computed from National Accounts Income and Expenditures, D.B.S. Ottawa.

This decrease was probably due to increased incomes, and as a consequence, enhanced ability to buy. In addition, the tendency conforms with the familiar observation that, as a rule, when incomes increase the proportion spent on foods decreases while the proportion spent on non food items increases (Engel's Law).[4]

A clearer indication of Canadian consumption patterns may be obtained by examining the trend in percapita consumption of important foods or food-groups over time. It is indicated in Table II that the patterns of food consumption in Canada have been changing with time. Per capita consumption in 1962 exceeded the 1947-51 average for the following foods: Red meats (5.0%), chicken meat (72.2%), beverages (21.3%), white potatoes (5.7%), vegetables (5%) and eggs (75.4%). The proportionate change in sugar consumption has been negligible while consumption of dairy products, whole milk, wheat flour, fats and oils has decreased. The most outstanding decreases in per capita consumption have been in fats and oils (15.8%) and wheat flour (13.7%).

The trend in average real prices for the same periods has been decreasing for red meats, chicken meat, dairy products, beverages, refined sugar, eggs, fats and oils; relatively stable for whole milk, white potatoes, wheat flour and vegetables (Table III).

Developments at the retail level of marketing may have direct and/or indirect repercussions on the farming sector. These may be transmitted to the economy in general. This is particularly true where

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[4]Gardner Ackley, Macroeconomic Theory, The Macmillan Company, New York, 1961, p.221.

TABLE II

CANADIAN PER CAPITA CONSUMPTION OF SELECTED FOODS AND FOOD GROUPS, AVERAGE 1926-39; FIVE YEAR AVERAGES, CANADA 1947-62*

Commodity	Unit	Annual Per Capita Consumption					
		Average 1926-39	Average 1947-51	Average 1952-56	Average 1957-61	1962	Change 1962 Over 1947-51
							Per cent
Red Meats	lbs	118.3	132.0	136.6	140.0	138.5	+ 5.0
Chicken meat	"	—	18.0	20.6	28.5	31.0	+72.2
Dairy Products[a]	"	431.6	440.8	416.8	419.8	410.3	- 6.9
Whole Milk	"	397.5	411.5	396.1	316.3	385.3	- 6.4
Beverages[b]	"	6.9	9.4	9.9	11.4	11.4	+21.3
Refined Sugar	"	89.2	97.6	96.3	96.0	97.0	- 0.6
White Potatoes	"	223.2	155.1	147.6	153.2	164.0	+ 5.7
Wheat Flour	"	177.6	153.6	145.3	137.4	132.6	-13.7
Vegetables[c]	"	—	—	34.3	34.4	36.0	+ 5.0[e]
Eggs	doz.	23.1	20.3	23.4	24.0	35.6	+75.4
Fats and Oils[d]	lbs	—	19.0	18.0	18.0	16.0	-15.8

* Source: Handbook of Agricultural Statistics, D.B.S., Ottawa.

[a] Includes milk, butter and cheese not converted to fluid equivalents.

[b] Includes coffee and tea.

[c] Includes tomatoes, cabbage, celery, lettuce, carrots, onions (fresh).

[d] Includes lard and shortening.

[e] Per cent change over 1952-56.

TABLE III

AVERAGE REAL PRICES[a] FOR SELECTED FOODS AND FOOD GROUPS, AVERAGE 1926-39; FIVE YEAR AVERAGES, CANADA 1947-62*

Price of	Average Real Prices					Trend since 1947-51
	1926-39	1947-51	1952-56	1957-61	1962	
	Cents					
Red Meats	37.9	60.1	58.5	59.0	60.0	Decrease
Chicken meat	—	104.6[b]	84.2[b]	64.8[b]	56.9[b]	Decrease
Dairy Products[c]	—	10.7	10.4	10.5	10.0	Decrease
Whole Milk	6.5	6.9	7.0	7.0	6.5	Relatively stable
Beverages[d]	71.1	81.1	94.6	77.0	75.0	Decrease
Refined Sugar	9.5	9.9	8.4	8.5	7.3	Decrease
White Potatoes	3.2	3.6	4.0	3.8	3.6	Relatively stable
Wheat Flour	6.5	6.4	6.4	6.5	6.5	Relatively stable
Vegetables	—	—	15.6	15.5	15.6	Relatively stable
Eggs	58.0	60.0	52.9	44.2	40.7	Decrease
Fats and Oils[e]	—	29.0	22.1	22.0	22.8	Decrease

* Source: Computed.

[a] Weighted for food groups

[b] Indicates price index

[c] See footnote "a" in Table II

[d] Indicates coffee and tea

[e] Indicates lard and shortening

perishable goods are produced and where preservation and storage facilities are either too expensive or are not readily available.

One typical generalization is that demand faced by farmers is a "derived" demand from the retail market. In this regard, prices and quantity changes at retail may lead to revenue gains or losses to farmers, depending on the physical properties of products and their demand characteristics. The less responsive demand is to price changes, the less the increase in farm revenue (or greater the decline) if output is increased. In the opposite case, the higher the demand elasticity the more economically advantageous will be increased output and the more disadvantageous will be curtailed output, in terms of revenue to producers, assuming cost relationships remain constant.

Marketing at the retail level is affected by underlying endogenous and exogenous factors in a free marketing institutional setting. These may evoke discernible consumer behaviour patterns which in turn may affect producers' economic success or failure. It is from this socio-economic setting that the present investigation emerges with the objective of measuring the relative responsiveness to changes or variations in the major determinants of demand, as stipulated by conventional economic theory.

The Problematic Situation

Forecasting, planning and decision-making in the agricultural and related sectors of the Canadian economy are at present restricted. An outstanding limitation is the lack of adequate basic parameters (elasticity estimates) which indicate responsiveness of farm products

to disturbances in the important determinants of demand. In this regard, Canadian investigators and policy makers have often relied upon estimates not altogether indigenous to Canada. As a consequence, there exists the need for more comprehensive coverage in analyzing demand for Canadian agricultural commodities.

It is conceivable that statistical parameters alien to Canada are not appropriate as bases for modifying production and marketing plans or for developing public policy with respect to farm price support and marketing controls. Possible differences in taste and preference, income and its distribution, demographic composition and its rate of growth could be influential in bringing about different and unique values of these parameters for individual countries, however close their geographic proximity.

Importance of the Study and Objectives

Governments and agencies involved in production, distribution, promotion and consumption of foods are interested in identifying the factors which cause consumption patterns to change, and in determining their important net effects. This study aims primarily at providing information upon which planning and control measures may be formulated by the authorities concerned.

At the farm level, for instance, this information may be expected to aid in guiding farmers and farm organizations toward better allocation of resources for desired output. They may also be helpful in indicating desirable shifts of resources between enterprises as necessitated by changes in domestic and foreign requirements.

An idea of the degree of responsiveness to price and income changes at the consumer level may indicate previously neglected, yet potentially promising areas for sales-intensification or relaxation.

Results obtained from an analysis of consumer demand may also be advantageously utilized in the public sector. Governments may be expected to find the indicators beneficial in a number of social programmes. For example, they would be useful in planning and administering subsidies to farmers in order to maintain, improve, or enhance the level of living on farms.

War-time and peace-time dependence upon these parameters should not be under-estimated. They could aid in forming the foundation upon which to base defence and administration planning, as well as in formulation of trade policies, and in directing public expenditure on research, relief work, international investments and foreign aid.

Specific Objectives

The specific objectives most relevant for the attainment of the general objective are:

1. to estimate price, income and cross elasticities for individual, edible farm products.

2. to cite implications and make forecasts of consumption in 1970, based on the elasticities calculated and trends observed in the relevant variables, in line with Moore's ideas as quoted by Fox:

> The business of economic science.... is to discover the routine in economic affairs. It aims to separate out the elements of the routine, to ascertain their inter-dependence and to use the knowledge of their connections to anticipate experience by forecasting from known changes to probabilities of

> correlated changes. The seal of the true science is the confirmation of the forecasts; its value is measured by the control it enables us to exercise over ourselves and our environment.[5]

Hypotheses and Assumptions

In order to delineate a workable dimension for the study and to facilitate meaningful interpretations of the results, it is necessary to formulate appropriate hypotheses and to make certain qualifying assumptions.

Technological progress and inter related social, economic and biological factors have resulted in spectacular changes in consumer outlook and behaviour, especially since World-War II. Marketing research has made it convincingly clear that these changes offer legitimate reasons for concern by businessmen at all levels of the marketing mechanism. Many investigators have emphasized the need for re-orientation of marketing techniques and a re-evaluation of consumer goals. Some of these changes are attributable to:

a. efforts at improving dietary standards with a view to promoting general health and resistance to infection and disease. In this regard, medical research and food consumption surveys have contributed a great deal to our knowledge of these changes.[6]

b. the abundance of new and improved products which pervade

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[5]Karl A. Fox, Econometric Analysis For Public Policy, The Iowa State College Press, Ames, Iowa, 1958, p.8.

[6]See for example Agricultural Marketing Service and Agricultural Research Service, Dietary Levels of Households in the United States, Household Food Consumption Survey, 1955, United States Department of Agriculture, Washington, D.C., Report No. 6, March 1957, p. 40.

the market thereby widening the spectrum of consumer choice.

c. consumers' desire to attain higher standards of living.

The Hypotheses

Within an environment of changing prices, incomes, tastes and preferences, an idea of consumers' quantity-responses should be enlightening. It is in pursuit of this consideration that the following are hypothesized:

1. There is a functional relationship between the quantity of a product consumed and its price.

2. There is a functional relationship between the quantity of a product demanded and disposable income.

3. There are functional relationships between the prices of some commodities and the quantities of certain other commodities purchased.

The Assumptions

The assumptions on which the empirical analysis is based are those typically given by economic theory on the concept of consumer demand. These include:

1. Rationality and consistency in consumers' behaviour patterns. In absence of such a qualification it becomes difficult to measure responses to changes in the structural variables realistically. It is to be expected that the elasticity estimates derived are truly representative of behaviour. This possibility is strongly supported under conditions where rational and consistent behaviour exist.

2. Retail prices, disposable incomes, population growth and fluctuating purchasing power of the monetary unit are the most influential quantifiable variables affecting consumer demand. The latter two variables may be explicitly introduced by incorporating them into the quantity and

3. The marginal propensity to consume (MPC) is less than unity and is relatively constant within any one income group. Furthermore, the MPC does not change within periods though it may change between periods. This implies that relative propensity to consume will be maintained over time regardless of social and economic changes and that the values of estimated parameters will be true indicators of consumer behaviour.

4. Relatively stable demand but variable supply for the commodities being investiaged. This ensures that over time a clearly defined demand relationship may be identified for study.

Changes in the structure of marketing may distort the reliability of elasticities derived, in absence of adequate adjustments. It is recognized that considerable changes in the retail structure of marketing have taken place since World War II. Important among these changes are: increased technology, hence greater economies in production and distribution; increasing prominence of vertical and horizontal integration as exemplified in corporate and private chain stores. These changes all appear to be of the type through which prices to the consumer are reduced. They do not seem to exert significant influence on the aggregate demand function proper. In this light, it is contended that the changes that have occurred in the marketing structure do not significantly affect either the validity of the methodology adopted in this thesis or the reliability of the coefficients derived.

Scope of the Study

The commodities selected for analysis are classified as follows:

1.	Red Meats	2.	Poultry Products
	Beef		Poultry meat[a]

[a] Includes turkey and chicken meats.

	Pork		Chicken meat
	Lamb		Eggs
3.	Cereals	4.	Dairy Products: Fats and Oils
	Wheat flour		Fluid milk and Cream
	Oatmeal and Rolled Oats		Butter
	Rye flour and Meal		Margarine
	Pot and Pearl Barley		Lard
	Buckwheat flour		Shortening
5.	Beverages and Refined Sugar	6.	Starches
	Coffee		White potatoes
	Tea		Wheat flour
	Sugar		
7.	Fruits[b]	8.	Vegetables
			Cabbage Onions
			Carrots Celery
			Lettuce Tomatoes

Economic importance and data availability were the main criteria considered in selecting these products for analysis.

The topic is developed as follows:

The introductory chapter deals with an evaluation of a statement of: historical income and consumption patterns, the problematic situation, the purpose and importance of the study, including the relevant objectives, hypotheses, assumptions and the scope of the study.

Chapters II and III are concerned with the theoretical framework of the study and the historical development of demand theory, respectively.

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[b] Entire category omitted because of insufficient data.

A concise exposition of the data and methodology is given in Chapter IV while Chapter V is devoted to an evaluation and interpretation of the statistical results. Commodities are treated individually within the logically defined categories.

An attempt at statistical prediction, discussion of economic implications for Canada, as well as recommendations for future research is contained in Chapter VI.

The entire study is briefly summarized in Chapter VII. Final sections are devoted to Bibliography and Appendices.

CHAPTER II

THEORETICAL BACKGROUND

In this chapter an attempt is made to discuss the relevant theoretical considerations underlying the empirical investigation. The discussion is developed on basis of the following specific subdivisions, namely: Static and Dynamic models, Partial and General approaches, Aggregative data, Random disturbances and Consumers' market behaviour.

Economic models form the bases of demand studies and are of four main types: micro statics, micro dynamics, macro statics, and macro dynamics. Micro describes that area of economic investigation confined to an individual consumer, firm, or other economic unit, while macro involves the study of an entire economy. Statics considers situations in a state of equilibrium; that is, there are no changes in technology, tastes, dating, or institutional setting. Emphasis is on the examination of final results obtained by a given set of forces and there is no attempt to analyse the paths by which these results are obtained. On the contrary, dynamics involves dating and changes in all variables. Consideration is given to the varying kinds of lags, to the way in which economic forces produce changes and to the paths of these changes.

Static and Dynamic Models

A static demand model may be expressed as:

$$Y = f(p_1, p_2, \ldots p_n, h) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where $p_1 \ldots\ldots p_n$ represent prices of related goods, h symbolizes per capita disposable income and Y, average consumption of a given commodity. By explicitly introducing time in the model, equation 1 assumes the dynamic form which

may be expressed as:

$$Y = f(p_1, p_2, \ldots\ldots p_n, h, t) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where t symbolizes time and the other variables interpreted as in equation 1.

Macro dynamics is the most under-developed and least explored of the four types of models. The adjustments, re-adjustments, and re-percussions resulting from a change in a single variable are not easily identified nor qualified for analysis. This presents a major obstacle since changes in a dynamic society, with its many complexities, cannot be fully evaluated. Static models, although less applicable to practical situations, are more developed and consequently, are often used to indicate tendencies within a dynamic framework. This explains the macro statics approach of the present investigation in spite of its nature and scope, in which many of the attributes of macro dynamics are implied. The macro element is contained in the basic objective, — to study demand characteristics for foods in the Canadian economy. Time as a dynamic factor is implicit in the period of coverage. The attempt to indicate changes in preference for foods is also characteristic of dynamic analysis.

Scitovsky states that the basic tasks of a dynamic macro economic theory are:

a. to trace the path described over time by the behaviour of a group.

b. to state the conditions under which this path approaches or diverges from the optimum, and

c. to analyse the speed with which equilibrium is approached.[1]

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[1] Tibor Scitovsky, Welfare and Competition, George Allen and Unwin Ltd., London, 1958, p.232.

Progress in dynamic economic analysis is retarded by the lack of precise governing laws typical of the physical sciences. Economic laws of change are basically a matter of extrapolating the future from present situations and the accuracy with which this may be achieved is often questionable. The attempt to tell how a demand function will move at a future date, and to project and anticipate its form and shape, cannot be efficiently handled by present-day "tools" of analysis. In light of these, most economic studies, for purposes of simplicity, have adopted the methodology of macro statics as the closest approximation to practical situations.

In statics there is the assumption of small fluctuations in error, so that demand functions are expected to remain stable. With changes in price, consumers purchase the quantities determined by their given incomes and personal preference. A shift in demand takes place when previous quantities are consumed at higher prices or when, at former prices, more is consumed. The analysis of each demand situation and the comparison of both provide an example of comparative statics in which no consideration is given to the time necessary and the mode of change that transpires. If the supply and demand functions are both stable, a statistical curve fitted to the scatter of observations gives rise to a kind of "mongrel" function.[2] A path resembling that of the demand function is traced out if demand is stable and supply variable. Such a situation is ideal for estimating demand relations. On the other hand, if demand is variable and supply is stable, the path approximates that of the supply function. Dynamics is intensified if both demand and supply become unstable, in which case, the type of analysis which

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[2]Lawrence R. Klein, An Introduction to Econometrics, Prentice-Hall, Inc., New Jersey, 1962, p.10.

may be undertaken becomes less clear.

In static and dynamic situations the consumer is said to be in equilibrium when there is no incentive to adjust behaviour, since no such attempt will further enhance satisfaction. It is sometimes questioned whether equilibrium is ever actually reached in a dynamic society with its innumerable goods and services and changes therein. Observation and a prior knowledge of the nature of changes in modern society are in support of the idea that if equilibrium is reached, it must be very brief in duration. Dynamic studies are therefore somewhat justified in emphasizing movements toward, rather than the actual attainment of equilibrium.

Static relations may be evaluated effectively in the "short run," since the period is one so short that it does not permit changes in incomes or established consumption patterns. Dynamics lends itself more readily to "long run" considerations, as there is the opportunity to analyse and evaluate changes and their repercussions. Predictions and forecasts based on long run behaviour are often quite reliable because there is adequate time for full adjustment to be reached in all variables. This explains the reason why as the period under consideration lengthens, demand studies for predictive purposes usually increase in precision and utility.

Partial and General Approaches

Demand studies are more useful and realistic when all relevant variables are considered in the derivation of demand functions. (It is important that these variables are not inter-correlated). Such an analysis is deemed "general" as opposed to the "partial" in which only a few variables are included. Researchers' preference for general equilibrium analyses is founded on the idea that, if the price of one commodity changes, former price

relationships in the market will be distorted. Disturbances initiated thus may have important implications for consumer demand. It is not difficult to visualize the series of unsurmountable difficulties arising from a complete general equilibrium analysis, and to appreciate the reason why most demand studies take the form of partial analysis.

The present analysis is essentially partial when evaluated in relation to the entire economy. If the agricultural sector alone is considered, the study may be regarded as a close approximation of general analysis, on the basis of the number of variables considered in most of the demand functions derived.

A completely satisfactory theory of consumer demand is yet to be developed, particularly at the macro dynamic level. However, simplified models, if carefully designed and utilized, are helpful in indicating tendencies, although there is the risk of evading some important and thought-provoking considerations.

Aggregation

Time series data, as opposed to those obtained from family budgeting, do not depict results of individual consumer behaviour. It is necessary that this aggregative device be justified in order that statistical estimates derived are in accordance with theoretical demand curves. Complications due to aggregation are intensified as the number of commodities selected for analysis is increased. That is, heterogeneity among groups is increased.

Difficulties arising from aggregative data are usually overcome by the assumptions that

a..the relevant demand functions are linear. In this way it becomes easy to aggregate and average prices, incomes, and consumption without serious mathematical implications.

b. incomes of all individuals change in the same proportion and the income elasticity of demand for each individual is roughly comparable.

c. prices of different goods change in the same proportion so that each group may conceivably be treated as a homogeneous entity.

d. there is minimum variability about mean observations so that consumers are relatively homogeneous in most respects.[3]

In demand studies it is customary, through logarithmic manipulation, to transform non-linear relationships into linear forms, thereby ensuring minimum disturbance from aggregative data. Analysis of market statistics may be helpful in an economy where questions of economic policy may require only knowledge of broad and general relationships. This is particularly true in the present investigation in which the tendencies discovered may help to form adequate bases for policy recommendations.

Random Disturbances

It has been empirically shown that relative prices and incomes are the chief factors affecting consumer demand. It is realized that these do not, by themselves, exhaust all possibilities, since exogeneous factors like weather, international friction, and sudden institutional disturbances, may be operative. Although these exogeneous factors exert some influence on consumer demand, they are spasmodic in occurrence, and are seldom quantifiable. These peculiarities make it difficult to include them directly in a statistical model. It is usual in econometric studies to recognize these disturbing influences and to treat them cumulatively in the model as error which is assumed to affect individuals randomly and normally so that their effects on dependent variables are of comparatively minor importance.

There are also errors arising from faulty measurements and obser-

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[3] Ibid., pp. 24-28.

vation. These tend to intensify the problem of aggregation. With accurate collection, treatment, and analysis, these errors may conceivably be at a minimum. In studies based on Regression analysis, observational errors are assumed to be virtually non-existent.

Consumers' Market Behaviour

Consumers choose from a wide variety of foods in the market. At any given time a varied collection of foods is purchased, since the practice of shopping for a single item is becoming less frequent. The average consumer's food purchases include, among other items, meats of various kinds and forms, vegetables, dairy products, beverages, fruits, bread, potatoes, and cereals. Whether a single commodity or a group of commodities is purchased, each consumer attempts to maximize his satisfaction for the given amount of money expended. The budget which yields maximum satisfaction may appropriately be termed the optimal budget.

A decision to purchase more of one food instead of another may be due to such factors as relative commodity prices in the market, disposable incomes, and personal preference, which are not usually constant over time. As these forces change consumers adjust their food purchases accordingly. On the assumption of rational behaviour, the value of the optimal budget will be less than, or equal to, but will not exceed disposable income. This assumption is supported by the common practice for consumers to enter the market prepared to spend a given amount of income on foods, regardless of market conditions.

The law of demand states that more of a commodity is purchased when there is a reduction in its price. This observation is characteristic of everyday marketing transactions. Experience has shown, however, that the law

is not necessarily true in all situations. There are foods for which quantities demanded increase as their prices increase. In spite of this modification to the law, there is no certainty regarding the nature and form of particular demand functions and the inter-relationships which exist between independent variables. The law does not state precisely the magnitude of consumption that will result from a given change in the price of a commodity. It does not indicate whether the demand function assumes a horizontal, steep, or gently falling slope. Furthermore, it does not indicate whether a price reduction leads to decreased, increased, or unchanged revenues from the sale of a given commodity. These apparent weaknesses make it necessary to conduct empirical investigations with a view to specifying particular forms and examining the relative effectiveness of the factors giving rise to different types of demand functions.

A Multiple Regression model (equation 3) based on least squares and comprising the major determinants of demand may be used in such empirical investigations.

$$Y = \alpha X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} \ldots\ldots X_{n-1}^{\beta_{n-1}} e^{\beta_n X_n} \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The constant α and the beta coefficients are estimated by "a" and "b" values respectively. Equation 3 expresses consumption (Y) of any commodity as a function of its price (X_1), disposable income (X_2), prices of related commodities ($X_3 \ldots\ldots X_{n-1}$), consumer preference (X_n) and true error (ε). The model may be used to indicate the change in consumption caused by a change in any of the independent variables. These changes are individually expressed as Price, Income, and Cross elasticities and are directly indicated by the respective

β_i (i=1 to n) values. The numerical value of the β_1 coefficient is the price elasticity of a given commodity. It shows the proportion by which consumption of this commodity changes in response to a small change in its price (other variables remaining constant). Income elasticity represented by the numerical regression coefficient of X_2 expresses the magnitude of change in consumption of the given commodity as a result of a change in consumers' real or money incomes. Inter-relations between two commodities may be shown by the appropriate numerical regression coefficients which indicate responsiveness in consumption of the one to a change in price of the other and vise versa. More specifically, the cross elasticity between a pair of products may be indicated.

A consumer intending to purchase a given commodity may at times be induced to purchase another. For instance, an increase in the price of beef may cause him to increase his purchase of pork relative to that of beef, and vise versa. Beef and pork are said to be substitutes one for the other. Two commodities are substitutes if "a rise in the price of one leads the consumer to buy more of the other."[4]

On the other hand, two or more commodities are sometimes consumed jointly. These are termed complements, since the consumption of one is complemented by the other. Common examples of complements are: bread and butter; and coffee, cream and sugar. Their joint consumption enhances flavour and completeness. Economists' definitions of complements differ in verbal content and expression but conform in meaning.[5]

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[4]George J. Stigler, The Theory of Price, The Macmillan Company, Revised Edition, New York, 1959, p.48.

[5]See for example: Ibid; Sidney Weintraub, Price Theory, Pitman Publishing Corporation, New York, 1949, pp.19-21; and Kenneth E. Boulding, Economic Analysis, Third Edition, Hamish Hamilton, London, 1941, p.226.

From the model it is also possible to identify substitutes and complements among foods. Statistical significance and the signs preceding the numerical coefficients are of major importance. A negative b_1 and positive b_3 coefficient inform us that, as the price of the first commodity increases, its consumption decreases, while that of the related commodity increases. The relatively high price of the one commodity induces consumers to curtail the quantities purchased and increase quantities of the other. A decrease in price is expected to result in the opposite behaviour. In either case, however, the commodities are substitutes.

With complements, the signs preceding the coefficients are similar. They are expressed in the negative when the price of one increases, or in the positive when the price is reduced.

There are varying degrees of substitutability and complementarity between products and the magnitude of response is not necessarily reversible in either case. Although it is difficult to cite examples of perfect substitutes and complements among foods, their theoretical possibilities do exist. Perfect substitutes and complements imply that commodities are exchanged or complemented in a certain constant or fixed ratio. Examples of "ordinary" substitutes and complements are common among agricultural commodities. If increased quantities of one of a pair of substitutes are to be obtained, there must be a decrease in the amount of the other. In the case of complements, both must be decreased or increased accordingly. The rate at which a consumer substitutes one commodity for another without changing the former level of satisfaction is termed the marginal rate of substitution (MRS). For example, if at any given level of satisfaction, it requires three units of one commodity to compensate for one unit of another, the MRS is one-

third (1/3). The tendency to substitute commodity A for commodity B is greater when the quantity of A already possessed is in excess of immediate needs, relative to that of B. Continued substitution of A for B or between any pair of commodities causes the respective valuations attached to each commodity to be altered. After a stage of substitution has been reached the consumer becomes increasingly reluctant to sacrifice more B for A, excepting in successively diminishing quantities. This illustrates the law of diminishing marginal rate of substitution and is illustrated in Table IV.

TABLE IV

COMBINATIONS OF COMMODITIES A AND B, YIELDING A GIVEN LEVEL OF SATISFACTION

A (Units)	B (Units)
6	16
7	13
8	11
9	10
10	9 1/2

Quantity responses to price changes exhibit a fairly definite pattern, implicit in the law of demand. Similar responses to income changes are less regular and predictable. The peculiar responses to income changes make it possible to classify items as necessities, normal and inferior goods. Consumption of necessities increases only to a certain level of income. Once the point of saturation is reached, increased quantities become superfluous and, in spite of further increases in income, demand remains unchanged. A normal good is one for which consumption increases as income increases and

vise versa. Inferior goods are those for which consumption increases in response to early increases in income. The quantity bought, after a time, decreases progressively as income continues to increase. Income sensitivity of this kind is exhibited by such foods as margarine and certain "cuts" of meats which are readily replaced by higher grade substitutes as soon as they can be afforded.

Quantity responses to changes in prices and incomes vary in magnitude. When a one percent price change results in a correspondingly proportionate change in quantity, demand is of unit elasticity. If the change in quantity is proportionately less than that of price, demand is inelastic. Finally, when a given change in price leads to more than a proportionate change in quantity purchased, demand is elastic. The price quantity relationship is in most cases negative. The negative numerical elasticities which result are customarily interpreted in absolute terms. For example, $E = 1$ denotes unit elasticity of demand; $E < 1$ denotes inelastic demand and $E > 1$ designates elastic demand.

The demand curve assumes the shape of a rectangular hyperbola when demand is of unit elasticity. Total expenditure is a constant at all possible price quantity combinations. Where demand is inelastic the curve slopes steeply downwards and total expenditure decreases as price decreases. In the case of an elastic demand the curve slopes gradually and total expenditure increases as price decreases.

Demand characteristics derived empirically may be expected to serve as reliable bases for decision making and national agricultural policy.

The above discussion presents an outline of postulates as given by economic theory. On basis of these postulates we are able to formulate

hypotheses which give direction and scope to scientific investigations. Since these postulates are in most cases handed down from logical deductions, it is necessary to conduct empirical investigations on which they might either be refuted or supported. Either alternative could aid in accepting these propositions as reliable explanations of consumer behaviour.

CHAPTER III

HISTORICAL DEVELOPMENT OF DEMAND THEORY

The theory of demand has undergone a series of revisions and modifications over the years. In this chapter the attempt is made to present from the literature reviewed a brief sketch of the historical development of the concept. It is developed from an evaluation of the works of Cournot, Gossen and Jevons and those of Pareto, Edgeworth, Marshall and others, to the contribution of modern day economists like Samuelson and Hicks.

Consumers' quantity responses to changes in prices and disposable incomes were detected by economists over a century ago as being characteristic phenomena possessing important economic implications. It was observed that, as a rule, more of a commodity or service was purchased when there was a reduction in its price, assuming other relevant factors constant. The opposite was true whenever there was a price increase. Income changes, because of varying consumer's tastes or preferences, objectives, and possible uneven distribution, resulted in varied and less predictable purchasing responses. Empirical results and observation over time substantiated these general tendencies which formed the basis upon which the "Law of Demand" was originally formulated.[1] This law was commonly stated as: "The price of goods varies

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[1] Henry Schultz, The Theory and Measurement of Demand, The University of Chicago Press, 1938, p.5.

directly as the quantity demanded and inversely as the quantity supplied."[2] Mathematically this may be expressed as:

$$P \propto \frac{D}{S}$$

where P denotes price, D quantity demanded, and S quantity supplied.

First Phase

To some early investigators, e.g. Cournot, the meaning of this exposition was somewhat ambiguous. The statement was interpreted to mean that "price varies directly as the quantity demanded, which depends on price, and inversely as the quantity supplied, which also depends on price."[3] This led Cournot in 1838 to attempt a less ambiguous statement of the law. "Let us admit", he said. "……..that the sales or the annual demand D is for each article, a particular function F(p) of the price p of such article. To know the form of this function would be to know what we call the law of demand or of sales"[4] Hence, Cournot's law was given as : D = F(p), expressing the relation between quantity purchased in response to small incremental price changes.

Dupuit, in 1844, attempted a formal description of price changes as an indirect measure of pleasure.[5] His approach was continued by Gossen (1854).[6] But the works of these writers were not publicized.

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[2] Ibid.

[3] Ibid., p.6.

[4] Ibid.

[5] Alfred Marshall, Principles of Economics, Macmillan and Co. Ltd., London, 1956, p.85.

[6] Ibid.

In 1871, Jevons and Carl Menger developed and published a part of these forgotten works. Walras also, in the years that followed, made a similar contribution. Jevons' work was outstanding in its simplicity and thoroughness of presentation. His style and ingenuity made his exposition easily comprehensible by even laymen of mathematics.

The law of demand, as propounded by the Lausanne School, was accredited to Walras who was first to postulate (in 1873) that the quantity of a commodity purchased in a given interval of time must be expressed not as a function of its price alone but also of all other prices.[7] The demand function then became:

$$D = f(p_1, p_2 \ldots, p_n),$$

where p_1 is the price of the commodity; $p_2 \ldots p_n$ the prices of all other commodities.

In the approach of Gossen, Jevons and Walras the notion of utility was basic. They regarded utility as a measurable (cardinal) and additive quality. It was argued that the total utility of specified quantities of "n" commodities was given by the sum of their separate utilities.[8] For example,

$$\text{Total Utility} = U_1(q_1) + U_2(q_2) + \ldots + U_n(q_n),$$

where U_i (i=1 to n) expresses the functional relationship between the stock of a commodity held and the utility derived from it.

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[7] Henry Schultz, op. cit., p.8.

[8] Herman Wold and L. Juréen, Demand Analysis, John Wiley and Sons Inc., New York, 1953, p.60.

Second Phase

Continued investigations in demand theory were later carried out by Edgeworth (1881), Antonelli (1886) and Fisher (1892). This era marked the beginning of the second phase in the development of demand theory. A premise common to these writers was that total utility was non-additive. Symbolically the utility function was expressed as $U = U(q_1, q_2, \ldots, q_n)$, where U again expresses a functional relationship and q_i (i=i to n) denotes quantity of the i^{th} commodity held. It was then that Edgeworth introduced the notion of indifference curves with the related concepts of contract curves and lines of preference. He was first to explain that the utility of a commodity was a function not only of the quantity possessed but also of the quantity of other commodities possessed by the consumer. On examining the above utility function the meaning imparted is that:

> If we interpret $q_1, \ldots q_n$ as a point in Euclidean space R_n, the relation $U(q_1, \ldots q_n) = C$ represents the locus of points of equal utility, $U = C$. Assuming $U(q_1, \ldots q_n)$ to be a sufficiently regular function, the locus will be an $(n-1)$ dimensional surface in R_n, called an indifference surface. The family of such surfaces obtained by allowing C to vary is called an indifference map. If n=2, ... the surfaces of the map become ordinary curves.[9]

Third Phase

The third phase in the study of demand theory was initiated by Pareto (1906). His approach was similar to that of his immediate predecessors but had a slightly different interpretation. Pareto assumed that each consumer had a scale of ordered preferences and that the indifference "map can be defined on a psychological-behaviouristic basis, without making use of the

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[9] Ibid.

concept of measurable utility".[10] In this regard the shape of the indifference map was of primary importance. Within a field of ordered preferences the consumer is able to make comparisons between budgets by way of making a definite choice. Pareto's approach also made use of the symbolism $U(q_1,....,q_n) = C$, but utility was now interpreted as a preference index function rather than as a quality of cardinal values. Quantification of utility appeared neither feasible nor necessary. All that was necessary, it was believed, was for consumers to choose consistently among the alternatives with which they were confronted. Another basic assumption popular to the thinking of this era was that if prices $(p_1 \ldots p_n)$ were constant, the consumer in his attempt to maximize satisfaction (subject to his constraining income) would expend his income Y in an optimal way. The optimal quantities $q_i (i=1 \ldots n)$ of the various commodities bought were functions of disposable income as well as of the array of all prices faced in the market. These therefore formed the relevant demand functions of consumers, for example:

$$q_i = f(Y, p_1, ..., p_n),$$

where i = 1 to n, q_i = the amount of the i^{th} commodity demanded, f expresses the functional relationship, Y = disposable income and $p_1 \ldots p_n$ = the prices with which the consumer is confronted. An underlying premise of demand functions was that utility was always maximised; that is, the mathematical relationship $U(q_1,....,q_n) = C$ was always a maximum. The income-constraint referred to above emphasised the fact that the sum of the individual expenditure on each commodity cannot exceed disposable income, that is, $p_1q_1 + ... + p_nq_n \leq Y$, where p_1q_1 is total expenditure on the first commodity, p_nq_n is

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[10] H. Wold and L. Jureen op. cit., p.61.

total expenditure on the n^{th} commodity and Y symbolizes disposable income.

In classical doctrine the additional utility derived from the last unit of a commodity purchased (the concept of Marginal Utility) was derivable. For example, if U represents total utility, q_1 and q_2 the quantities of the first and second commodities purchased respectively, then the respective marginal utilities from these quantities are given by:

$$\frac{\partial U}{\partial q_1} \cdot dq_1 \quad , \text{ and } \frac{\partial U}{\partial q_2} \cdot dq_2.$$

According to Gossen, "for the optimal budget, marginal quantities of equal cost have equal marginal utilities".[11] Consequently, the above relationship yields equal marginal utilities expressed as:

$$\frac{\partial U}{\partial q_1} \cdot dq_1 = \frac{\partial U}{q_2} \cdot dq_2 \text{ , when } p_1 dq_1 = p_2 dq_2$$

In utility analysis a state of equilibrium was said to have been attained when the amount of utility per monetary unit's worth of each good is the same for each commodity[12]. This implies that

$$\frac{MU_{x_1}}{p_{x_1}} = \frac{MU_{x_2}}{p_{x_2}} = \cdots = \frac{MU_{x_n}}{p_{x_n}} = \text{a constant, K.,}$$

where MU = marginal utility and X_i (i=1 to n) = the quantity of the i^{th} good demanded.

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[11] H. Wold and L. Jureen, op. cit., p.62.

[12] R.H. Leftwich, The Price System and Resource Allocation, Holt, Rinehart and Winston, Revised Edition, New York, 1963, p.57.

Slutsky in 1915 deduced a set of general formulae to demonstrate changes in the optimal budget in response to infinitesimal changes in all prices ($p_1 \ldots p_n$) and income. These formulae characterized what are now regarded as the Slutsky relations[13], and showed a definite improvement in the understanding and development of demand theory. One important advantage of the formulae is that they lend themselves to direct transformation to price and income elasticities[14].

Reasons for Renewed Interest in Demand

Alfred Marshall, writing in 1920, mentioned that "until recently the subject of demand or consumption has been somewhat neglected.". ".... economists said little on the subject, because they really had not much to say that was not the common property of all sensible people. But recently several causes have combined to give the subject a greater prominence in economic discussions".[15] The causes to which Marshall referred were:

1. Ricardo tended to lay disproportionate stress on production cost in his analysis of the determinants of exchange value. It was popularly felt that such a treatment was more to be desired since there was no corresponding emphasis on the law of satiable wants[16]. Although Ricardo and his followers recognized that demand was just as important as supply in determining value, their ambiguous explanations had led to much confusion.

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[13] E.E. Slutsky, "On the Theory of the Budget of the Consumer", Readings in Price Theory, George Allen and Unwin Ltd., London, 1960, pp. 27-56

[14] H. Wold and L. Jureen, op. cit., p.62.

[15] Alfred Marshall, op. cit., pp.70-71.

[16] Ibid., pp. 78-79.

2. The application of mathematical language introduced more exact habits of economic thought. It promoted clarity, precision and distinctness in statements of the premises upon which reasoning is based, and contributed largely to the analysis of demand. The mere attempt to state clearly by means of mathematics how demand was to be measured opened up new aspects of the main problems of economics. It became possible to collect, arrange and analyse consumption statistics so as to elucidate important and difficult questions.

3. A closer consideration of the impact of wealth; that is, an examination of how far the exchange value of any element of wealth accurately represents an addition to happiness and well-being[17].

The Law of Demand as known in modern times must be credited mainly to Marshall, recognizing of course the contributions of Cournot. In this regard, some writers have even alluded to the Cournot-Marshall Law of Demand[18].

A review of pertinent literature conveys Marshall's invaluable contribution. His arguments were convincing, provocative and thought-stimulating. Without such high-calibred efforts it is possible that the deeper ramifications underlying demand theory would have remained dormant and uninvestigated for a still longer period of time. Marshall stated his general law of demand as follows:

> The greater the amount to be sold, the smaller must be the price at which it is offered in order that it may find purchasers; or, in other words, the amount demanded increases with a fall in price and diminishes with a rise in price.[19]

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[17] Ibid., p.71.

[18] Henry Schultz, op.cit., p.7.

[19] Alfred Marshall, op. cit., p.84.

In the above statement Marshall omitted an important modification which caused some investigators to criticize the law as being a sweeping generalization. Giffen, for example, introduced what came to be known as the Giffen Paradox[20], which explains that prices and quantities at times do move in the same direction, as in the case of an inferior, necessary commodity on which a large proportion of consumer income is expended. Such a qualification was necessary in describing individual rather than heterogeneous responses since a good many of the 'inferiorities' which might be expected to show themselves in analysis of individual behaviour will not show up in the behaviour of heterogeneous groups where there tends to be a balancing-out effect[21].

Modern economists support the notion of ordinal preferences. In order to ensure best results in this type of analysis, Fisher outlined some Integrability Conditions which should be satisfied[22]. Wold and Jureen are of the opinion that if it were not for the introduction and confusing discussion of these integrability conditions, greater progress would have been made in the development of demand theory after Slutsky's "break-through".

The controversies regarding these "conditions" resulted from misinterpretation of the concept. Some authorities argued that the concept pertained somewhat to the order in which commodities comprising the optimal

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[20] Ibid., pp. 109-110

[21] J.R. Hicks, A Revision of Demand Theory, Oxford 1959, pp.67-68

[22] Paul A. Samuelson, Foundations of Economic Analysis, Harvard University Press, Cambridge, 1963, p.95.

budget were actually consumed. The varying interpretations led to a number of approaches among which were Pareto's theory of 'open cycles', the treatment by Hicks and Allen based on marginal substitution and compensating income variation, as well as Samuelson's approach based on revealed preference[23]. Later clarification of and agreement in the meaning of integrability portrayed the concept as "a fundamental theorem in the theory of preference fields"[24] in which there were no circular ordering[25]. The general concensus was that unless these "conditions" were explicitly stated in the formulation of hypotheses the different approaches cited above all became contradictory. With this precaution taken, it was evident that in actuality there existed no controversy and, instead of being different postulations, there was in fact a unification of the theory.

Pareto's Theory

Pareto's theory aimed at the analysis of static behaviour and was founded on three basic and seemingly realistic axioms [26] :

(a) The axiom of comparison : A consumer possesses a definite order of preferences. With two alternative budgets, A and B, three combinations were possible: either A was preferred to B, B preferred to A, or A and B furnished the same level of satisfaction, in which case the consumer was indifferent between them. A preference field therefore was descriptive of all commodities governed by an order of preferences.

(b) The axiom of transitivity: In order to illustrate, at least three budget

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[23] H. Wold and L. Jureen, op. cit., p.63 [24] Ibid.

[25] J. R. Hicks, op. cit., pp. 23, 123.

[26] H. Wold and L. Jureen, op. cit., p.82

alternatives should be considered. Assume the combinations were A, B and C. If A were preferred to B, B preferred to C, it followed from transitivity that A was preferred to C. Closely associated with this concept was that of unidirectionality[27], which invalidated the possibility of reversibility, since consistent ordering had to be maintained. For example, assuming $>$ denotes "preferred to", then the above illustration of transitivity and unidirectionality may be expressed as: $A > B > C$. Reversibility of this order implies a different ordering which introduces inconsistency since, in the same market situation, the identical combination may not at the same time be preferred to, as well as, rejected for another.

(c) The axiom of choice: The rational consumer was assumed to choose that budget which was preferred to all others, providing all alternatives were available to him. Such a budget was referred to as the optimal budget and any given set of optimal budgets which was equivalent to the consumer was regarded as the "optimal budget set"[28].

Modern Contributions

Hicks[29] and Samuelson[30] are recognized for their outstanding contributions to demand theory. Hicks in his treatment assumed "Weak" ordering[31]

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[27] J. R. Hicks, op. cit., pp. 27-28.

[28] H. Wold and L. Jureen, op. cit., p.82.

[29] J. R. Hicks, op. cit., pp. 1-148.

[30] Paul A. Samuelson, "Consumption Theorem in Terms of Overcompensation Rather than Indifference Compensation", Economica, 1953, pp. 1-9.

[31] J. R. Hicks, op. cit., pp. 36-46.

of preferences as opposed to Samuelson's "Strong"[32] ordering. Under Strong ordering the combination of goods chosen is preferred to all other combinations available. In Weak ordering the combination chosen is not necessarily preferred to all others; it might furnish a similar amount of satisfaction as some other combinations in the set. In this case, there is indifference among the available choices. Strong ordering is associated with discrete measurements while Weak ordering introduces the notion of continuity and, therefore, fine divisibility.

For purposes of simplication both Hicks and Samuelson aggregated all commodities other than that on which the price changed. Hicks' aggregate was symbolized M while Samuelson used X_i (i = 2 to n). The composite M, according to Hicks, as an index of purchasing power, was justifiably regarded finely divisible and hence, weakly ordered on the Y axis. The commodity on the X axis was also assumed finely divisible. Many economists have argued that the assumption of fine divisibility of the X commodity is unrealistic since the units may be purchased in discrete quantities. Hicks, in an attempt to justify his use of weak ordering throughout maintained that the degree of indivisibility of this commodity is negligible. His explanation is primarily centred around the fact that currencies are composed of very small units whose quantity-equivalents of goods can be calculated and, hence, purchased by consumers. Furthermore, as he explained, his aim was to show average tendencies, not rigid laws. Finally, with the composite M occupying such a large relative position in the consumer's budget, the assumption of fine divisibility of the X commodity represents a minor departure from reality.

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[32] Ibid.

Hicks' Approach

Figure II illustrates Hicks' approach[33]. The commodity X (whose

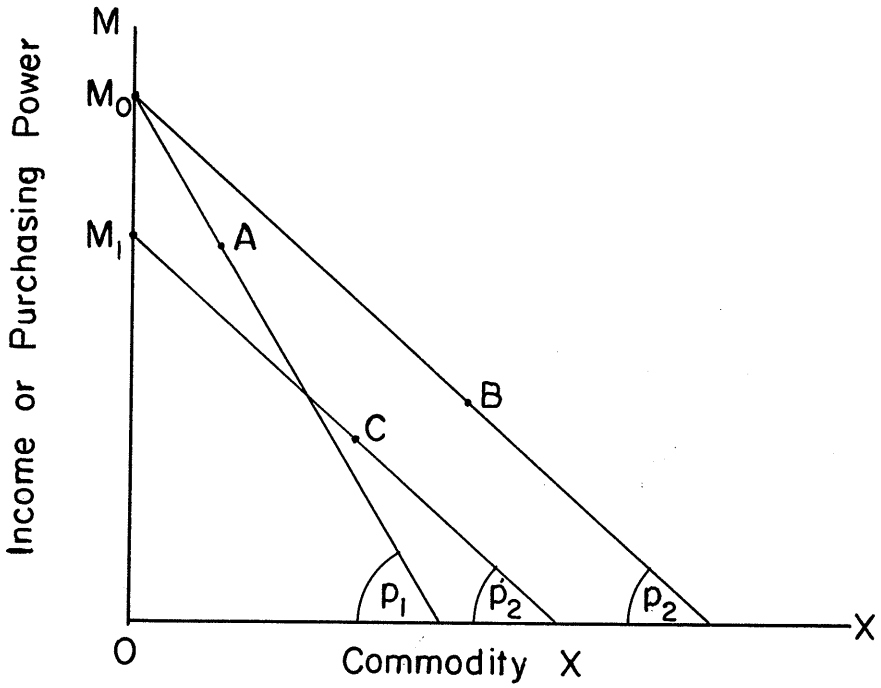

Figure II : Hicks' Interpretation of Substitution and Income Effects; Compensating Income Variation.

price was allowed to vary) was assumed to be a "normal" good. The composite M (representative of income or purchasing power) was shown on the Y axis. With the p_1 price-relation, the consumer selected say, the A equilibrium combination at the M_0 level of income. With this level of income maintained and a small reduction in the price of X (to p_2), the consumer was normally expected to be at equilibrium with a combination such as is depicted at B. Increased

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[33]This figure as well as others following were not drawn to scale. As a result, the proportions of change in prices and quantities are somewhat distorted. Nevertheless the figures are used for purposes of visual clarity.

purchase of X was inevitable according to the following algebraic formulation.

At equilibrium: $\frac{MU_{x_1}}{P_{x_1}} = \frac{MU_n}{P_n}$ = a constant marginal utility of money (MU_m).

This is equivalent to : $P_{x_1} \cdot MU_{(money)} = MU_{x_1}$ (where $MU_{(money)}$ is a constant). If P_{x_1} falls, $P_{x_1} \cdot MU_{(money)} < MU_{x_1}$. The MU_{x_1} must be adjusted, that is, fall, in order to maintain equilibrium. In order for the MU_{x_1} to fall, more of the X_1 commodity must be taken.

The real-income position of the consumer is enhanced by the reduction in the price of x_1. Hicks argues that, for welfare reasons, if the amount $M_0 - M_1$ of income (the Compensating Variation in Income) were taken from the consumer in order that his former level of satisfaction be maintained, the new level of equilibrium would be indicated at about the C combination. Combinations A and C were regarded as indifferent. Although the formerly enhanced purchasing power was reduced, more of the X commodity would be substituted for the relatively expensive. The movement from the A to the C combinations was termed the "Substitution Effect", characterized, in most cases, by an increase in quantity, that is, where normal goods are involved. If the income taken away were returned to the consumer, quantity purchased would increase further, and the consumer would select the B combination in preference to that at C. This movement would be caused not by substitution (since the same price relationship prevailed), but by increased income, and was termed the "Income Effect".

In general Hicks subdivided the Price Effect into two components: the Substitution and Income Effects. He explained that the Income Effect would invariably be less than the Substitution Effect since the income change resulting from a small change in price of one of many commodities is expected

to be very small, relatively, or even insignificant.

In further illustrating his method of Compensating Variation in income, Hicks made use of the marginality concept, illustrated in Figure III.

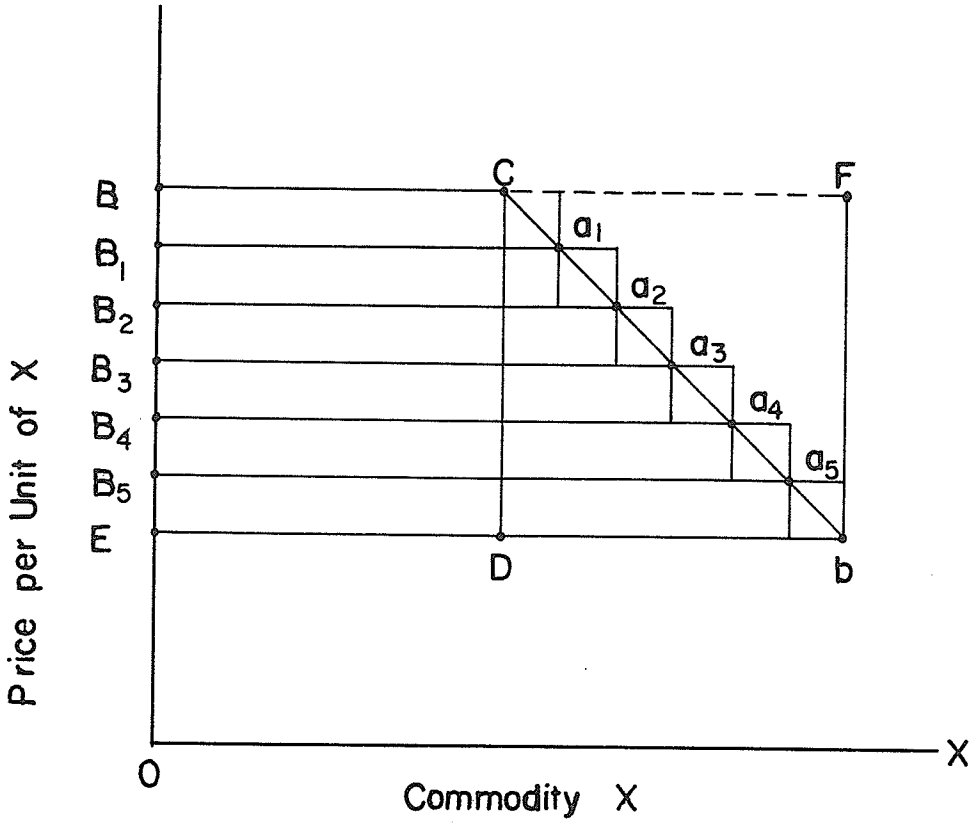

Figure III : The Method of Compensating Income Variation Illustrated by the Marginality Concept.

Instead of a one-unit price reduction from B to E, Hicks assumed a series of equally proportionate but separate reductions, B to B_1, B_1 to B_2 , and so on to E. Consumption of the X commodity increased with successive price decreases and compensating income variations. The points illustrating these increases (a_1, a_2, a_3 ...b) represent a continuum of indifference. By the axiom of transitivity, if C is indifferent to a_1, and a_1 is indifferent to a_2, etc., a_2 is indifferent to C and further, b is indifferent to C. By connecting these points of indifference (on the assumption of fine divisibility), the overall Compen-

sating Income-Variation was seen to represent a continuous expansion along Cb, lying between the inner and outer rectangles (Cost Differences) that would result from a price fall and price increase respectively.

The Cb curve as a demand curve is somewhat different from Marshall's which resulted without compensation. Consequently Cb was termed a Compensated demand curve in comparison to the Uncompensated Marshall curve. Movement along Cb illustrated the Substitution effect. Since it was previously established that substitution caused the quantity of X demanded to increase, the slope of Cb must be negative.

Samuelson's Analysis

Samuelson's analysis based on the concept of Cost Difference assumed that in the presence of changing prices, the amount purchased remained fixed. In Figure III, with a one-unit price-fall equal to BE, the amount which should be taken from the consumer in order that he might just be able to buy the same combination as previously is represented by BCDE, that is, the Laspeyres Cost Difference. The amount to be given to the consumer in case of a price increase from OE to OB in order to permit him to continue purchasing the Eb quantity of X is represented by EbFB or the Paasche Cost Difference. Figure III indicates pictorially that Hicks' Compensating Variation in Income (hereafter referred to as C.V.) shown by BCbE is greater than Samuelson's Cost Difference (C.D.) depicted by BCDE. Hicks explained that the size of the excess (CDb) is attributed to the substitution that existed and so the total Substitution Effect is appropriately illustrated by CDb. Similar relationships between C.V., C.D. and the Substitution Effect can be identified on a small scale when marginality in price changes is examined (again as shown in Figure III).

Note that the C.V. in a price-decrease becomes the Equivalent Variation in Income[34] (E.V.) when price increases, and vise versa. Furthermore, C.V. resulting from a price decrease exceeds the corresponding Cost Difference $C.D._1$ but is less than $C.D._2$ resulting from a price increase. Functionally therefore, $C.D_1 < C.V. < C.D_2$.

The introduction of Marshall's demand curve to Hicks' analysis, causes Figure III to be modified as shown in Figure IV, where Cb is the compensated demand curve and CU, the uncompensated; CDb and UGc are the substitution effects, bU and cC the Income Effects. With the price-fall Cb is the C.V. while Uc is the E.V.; with the price-increase, Uc is the C.V. while Cb becomes the E.V.

Samuelson's method of Cost Difference is illustrated in Figure V. Samuelson did not deny the possibility of substitution but regarded it merely as a means to the end. He contended that the act of substituting relatively cheap goods for the more expensive resulted in an Overcompensation Effect rather than a Substitution effect. By way of illustration, the X_1 commodity is represented on the horizontal axis and all others $X_i (i = 2 \text{ to } n)$ on the vertical axis. With the price relation represented by HT the combination A represented equilibrium for the consumer. If the price relation changes to HS, equilibrium would normally change to say, B. In view of the enhanced real income position, the quantity HH' (C.D.) could be taken from the consumer thereby enabling him to continue purchasing the same quantity (A combination) as before.

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[34] The amount of money income which when taken from the consumer results in a quantity response similar to that of a price increase.

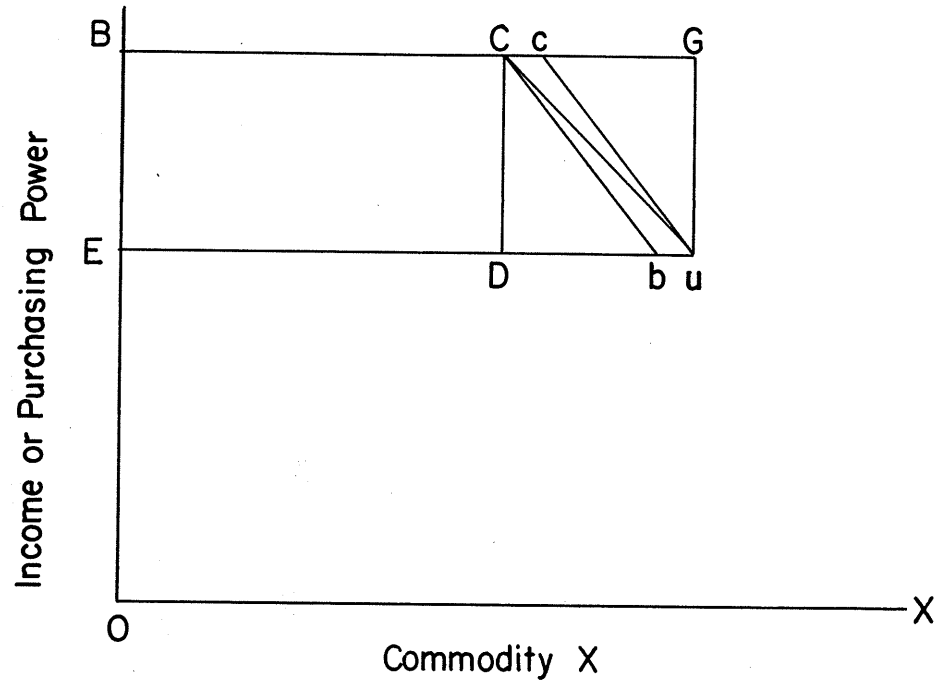

Fig. IV. Illustration of Compensated and Uncompensated Demand Curves.

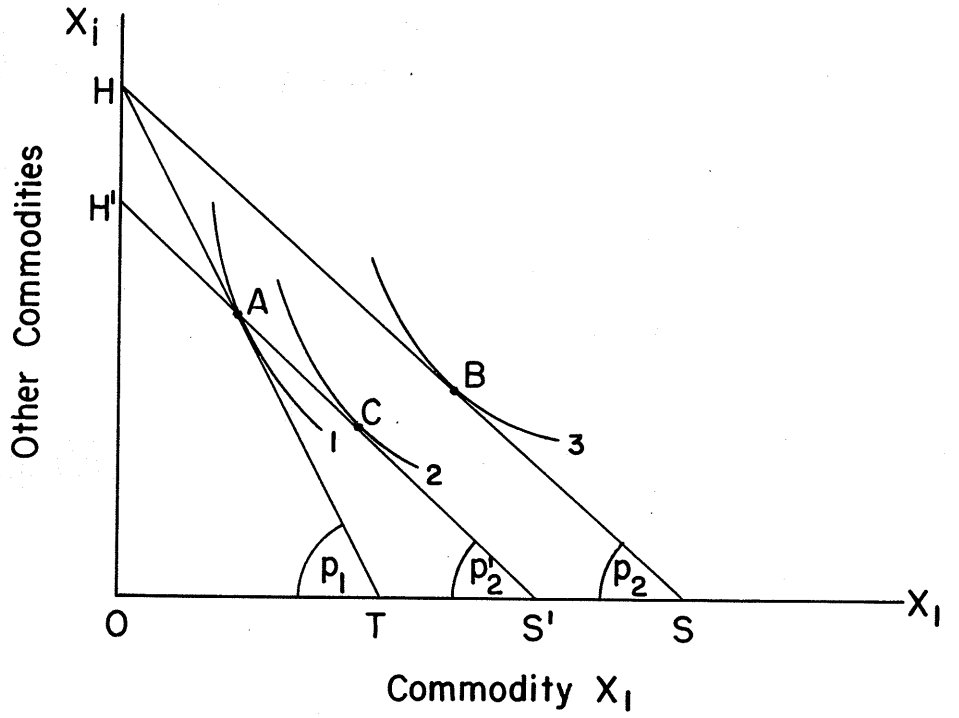

Fig. V. The Method of Cost Difference – Samuelson.

In presence of the lower price of X_1, however, the consumer would be expected to increase his consumption of X_1 as represented at C. By not having been deprived of sufficient income the consumer was assumed under-compensated in terms of income. Under-compensation caused satisfaction to increase and, therefore, the consumer would be over-compensated, in terms of satisfaction. Indifference curves are used in Figure V to illustrate the Overcompensation effect. It is seen that the C combination is indicative of a higher level of satisfaction than that at A and that the movement from C to B illustrates the Income Effect, as in Hicks' analysis.

Hicks and Samuelson Compared and Contracted.

The approaches adopted by Hicks and Samuelson may be compared and contrasted on the basis of some well-defined criteria:

(a) Assumptions: Samuelson as well as Hicks assumed rationality and given preferences, transitivity, consistent ordering, static and partial analyses. Hicks made use of Weak Ordering. In his opinion it was a less restrictive assumption one which promised versatility and offered greater scope for his analysis and demonstration of compensation, substitution, and consumer indifference. With the assumption of weak ordering his aggregation of all commodities, except one, and his treatment of the "composite" as comprising finely divisible units, was intended to be accepted as logical and legitimate developments.

Samuelson, on the other hand, assumed Strong ordering with the result that the notions of continuity and indifference could not be explicitly stated nor demonstrated. Similarly, the treatment of aggregates could not be assumed finely divisible.

(b) Method of Analysis: In demonstrating the methods of Compensating variation and substitution, Hicks utilized the idea of marginality. Samuelson's demonstration of compensation through the method of Cost Difference was possible only through finite analysis, in view of his regid assumption of strong ordering.

(c) Some Concepts: Hicks explained that substitution exists and that it is a phenomenon common to all consumers. Samuelson demonstrated over-compensation rather than substitution. Consequently, while Hicks analysed the Price Effect in terms of Substitution and Income Effects, Samuelson saw it in terms of over-compensation and Income Effects.

(d) Final Consideration: Hicks' assumption of weak ordering appears realistic but his method in general necessitates rather difficult measurements. With the difficulty of measurement surmounted, the approach could conceivably be used in the implementation of government policy. Samuelson's method offers more practicability since all that is necessary is for the same combination of goods to be purchased regardless of price changes.

A few attempts at developing a dynamic theory of demand have been made. However, much more remains to be done in this direction. It has been observed that statistical approximation of a suitable form of demand function requires numerous observations covering a prolonged period of time. During the interval, changes of a dynamic nature may occur. Schultz, viewing this possibility, suggested that variables which are functions of time should be included in the model. The appropriate demand function, a modification of the Walrasian type was therefore thought to be of the form:

$$D = f(p_1, p_2 \cdots, p_n, R, t)$$

where D = quantity demanded, p_1 = the price of the commodity demanded, $p_2 \cdots p_n$ = prices of other commodities, R = disposable income and t = time, a "catch all" category for the factors which cannot be conveniently measured separately and which are changing slowly and smoothly.

A dynamic theory involves a knowledge of both the change and velocity of the economic system. In this regard it is suggested that the quantities consumed, as well as some other elements, must be considered vectors which are functions of time[35]. Economics in its present state of development cannot, with any degree of certainty resolve possible movements in demand at a specified future date. Present "tools" and methods of analysis permit only approximations. Therefore, the best that can be done, is "to make a study of a series of statical equilibria, isolate their routine of change, if it exists, and hope that this routine will continue to operate in the future."[36]

The Cobb-Douglas formulation is applicable to the approaches of both Hicks and Samuelson. Hicks' theory is particularly relevant since the weak ordering technique makes it possible to identify substitution, income and cross effects derived by the Cobb-Douglas function. Samuelson's finite analysis is applicable if arc elasticity rather than point elasticity is desired. Identification of the substitution (over compensation) effect is rendered difficult by Samuelson's assumption of discreteness.

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[35] Henry Schultz, op. cit., p.56.

[36] Ibid., pp. 57-58

CHAPTER IV

THE DATA AND METHOD OF ANALYSIS

This chapter presents a discussion of the variables chosen, sources and preliminary treatment of the data, limitations of time series data, the model, and the method of analysis adopted.

Choice of Variables

The variables selected as being most pertinent in analyzing the topic are those typically posited by economic theory, namely: real price of a commodity, real disposable income per capita, real prices of related commodities, and tastes.[1] Where it appeared that advantages could have been gained by increasing the number of independent variables, the analyses were so conducted for the commodities involved.

Sources of Data

Traditionally, demand analyses are conducted on data obtained from family budgeting and market statistics or time series. For purposes of this study, time series were utilized in view of the period of coverage, availability of data and the costs involved. The main sources consulted were the Dominion Bureau of Statistics publications. It was realized that quarterly or monthly data could more accurately reflect consumption responses to price and income changes but data so arranged were not available.

Preliminary Treatment of the Data

Quantity consumed was regarded as the dependent variable. This was

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[1] George J. Stigler, The Theory of Price, The Macmillan Company, Revised Edition, New York, 1959, p.43.

based on the observation that in all practical market situations for foods the consumer is a veritable price-taker. The consumer is confronted with quoted prices and bargaining is usually absent. In reality, it is a case of unilateral dependence at the retail level compared to wholesaling where some degree of bilateral dependence exists, since, by offering to purchase more of a good, the buyer is sometimes able to secure reductions in the price previously quoted.

Taste was included as a variable in the analysis of some commodities in spite of the observation that, for a large proportion of consumers, tastes are relatively stable and "much of the greatest part of short-run changes in consumption can be explained in terms of monetary factors."[2] By including taste, it was possible to evaluate changes in preference for these commodities over time.

Factors other than prices and disposable income are sometimes responsible for changes in quantity responses for foods. In this regard, inflation, deflation and population growth are prime examples. These considerations were explicitly introduced by treating:

(a) consumption on an annual per capita basis, (b) prices and disposable incomes in "real" terms by using consumer price indexes based on 1949 as deflators.

Original prices for red meats were reported according to specific "cuts". These prices were consolidated by "weighting" on basis of the proportion of carcass weight represented by each "cut" as supplied by Canada Packers Limited.

Changes in consumers' preference for commodities were determined by introducing an additional variable representing consumers' preference. Treat-

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[2] Ibid., p.53.

ment of this variable was similar to that which is often used; that is, entering absolute numbers 1....n for successive years. The direction of sign (plus or minus) preceding the coefficient of this variable indicates increase or decrease in preference over time. The magnitude of change was measured in terms of the statistical significance of the coefficient itself.

Limitations of Time Series Data

In analysing time series data problems of autocorrelation and multicollinearity usually arise. Autocorrelation occurs when there is correlation between successive observations in the series so that the residuals are not randomly distributed. This is the case in demand studies, for example, where each price of a given commodity in successive time periods shows some relationship to preceding and following prices. The preferred situation is one in which residuals at the time t are not influenced by those at time t_{-1} and also, do not affect the results at time t_{+1}.

The problem of Multicollinearity exists when two or more theoretically independent variables are significantly correlated. For example, in estimating a demand relation from time series data, correlation is suspected (through a priori reasoning) between prices and disposable incomes, because of their role in determining business cycles. High intercorrelation between independent variables leads to indeterminacy of observations and the normal equations derived fail to produce reliable elasticities. Some amount of indeterminacy may be effectively eliminated by Conditional Regression Analysis in which one of the elasticities is known a priori and the other or others are determined by least squares.[3]

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[3] H. Wold and L. Jureen, Demand Analysis, John Wiley and Sons, Inc., New York, 1953, p.47.

Failure to adjust the data for both these disturbances usually results in coefficients that are misleading so that their applicability to real situations is limited and questionable. Tests have been devised and recommended for examining randomness of residuals with a view to ensuring relatively reliable coefficients.[4] That which has been most often used is Von Neuman's Ratio (K) which involves calculating the ratio of the "mean square successive difference" to the variance of estimate.[5] That is, autocorrelation among sample residuals is calculated with respect to the variance of estimate.

Von Neuman's Ratio (K) is given as:

$$K = \frac{\Delta e^2}{S_e^2}$$

where $\Delta e^2 = \frac{\sum_{1}^{n-1}(e_t - e_{t-1})^2}{n-1}$ and $S_e^2 = \frac{\sum_{1}^{n} e_t^2}{n}$,

Δe^2 is a measure of autocorrelation and e_t is the residual at time t.

Critical K values have been calculated and tabulated for one and five per cent levels of significance.[6] If the calculated value of K is less than the lower critical value there is positive autocorrelation. If the value is greater than the higher critical value, there is negative autocorrelation. A calculated value of K which falls between the lower and upper critical values

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[4] M. Ezekiel and K.A. Fox, Methods of Correlation and Regression Analysis, John Wiley and Sons Inc., New York, 1961, p.335.

[5] Ibid.

[6] Ibid., p.341.

indicates that autocorrelation is tolerable. The method of First Differences is suggested as an effective device for lessening autocorrelation. Omission of one variable is an effective treatment when multicollinearity is high.

The Model

An aggregate demand model utilizing the Cobb-Douglas formulation was arbitrarily chosen for use in deriving national demand functions for selected agricultural commodities. The following are valid theoretical reasons which prompted the use of this type of model:

a. the method is relatively simple. Coefficients are comparatively easy to calculate and a "good fit" to the data is usually secured.[7]

b. in comparison to other methods, the different elasticities are calculated directly since they are the numeric values of the b_i indexes (i=1.....n).

The basic algebraic form of the model was

$$Q_{it} = \alpha X_{it}^{\beta_1} X_{2t}^{\beta_2} X_{3t}^{\beta_3} \ldots\ldots e_t^{\beta_n X_{nt}} \varepsilon$$

Expressed in logarithmic form this model appears as

$$\log Q_{it} = \log \alpha + \beta_1 \log X_{it} + \beta_2 \log X_{2t} + \beta_3 \log X_{3t} + \ldots + \beta_n X_{nt} \log e + \log \varepsilon \quad (4)$$

or

$$\log \hat{Q}_{it} = \log a + b_1 \log X_{it} + b_2 \log X_{2t} + b_3 \log X_{3t} + \ldots + b_n X_{nt} \quad (5)$$

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[7] A.R. Prest, "Some Experiments in Demand Analysis," Review of Economics and Statistics, Volume 31, 1949, p.36.

Equation 5 is obtained from equation 4 on basis of the assumption that the a and b values are unbiased estimates of the alpha (α) and beta (β) coefficients, and that estimated consumption ($\hat{Q}_{it}$) rather than actual consumption (Q_{it}) is evaluated.

The variables in equation 5 were interpreted as follows:

Q_{it} = consumption of the i^{th} commodity at time t (i = 1...n).

X_{it} = real price per unit of the i^{th} commodity at time t,

X_{2t} = real disposable income per capita at time t,

X_{3t}... X_{n-1t} = real price per unit of related commodities at time t,

X_{nt} = the change-in-taste variable, a = the numeric constant,

$b_1, b_2, b_3, \ldots b_{n-1}$ = the elasticities with respect to X_1, X_2, $X_3 \ldots X_{n-1}$ respectively, e denotes a constant (2.71828), the natural logarithm of which is 1, and $b_n X_{nt}$ the index to which e is raised.

The data for beef and pork were pre-tested for autocorrelation and multicollinearity by variations of the basic model as shown in equations 6, 7 and 8 below, with a view to selecting the form which gave the most satisfactory results in terms of these disturbances. Coefficients were therefore derived and evaluated from:

$$\log \hat{Q}_{it} = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 X_4 \quad \ldots\ldots\ldots\ldots (6)$$

$$\log \hat{Q}_{it} = \log a + b_1 \beta \log X_1 + (1-\beta) \log X_2 + b_2 \Delta \log X_3 + b_2 \beta \log X_4 + b_3 \Delta \log X_5 + b_3 \beta \log X_6 + b_4 X_7 \quad \ldots\ldots\ldots\ldots\ldots (7)$$

$$\Delta \log \hat{Q}_{it} = \log a + b_1 \Delta \log X_1 + b_2 \Delta \log X_2 + b_3 \Delta \log X_3 + b_4 X_4 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Equation 6 was a direct application of the basic form (equation 5) with the variables similarly interpreted.

It was hoped that the method of Partial First Differences (implicit in equation 7) would aid in removing or ameliorating disturbances arising from autocorrelation and multicollinearity and, at the same time, would make it possible to derive short run and long run elasticities. In view of the manipulations it was necessary to interpret the independent variables in equation 7 as follows:

X_1 = price of the commodity,

X_2 = previous year's consumption of the commodity,

X_3 = change in annual disposable income,

X_4 = previous year's disposable income,

X_5 = price of a related commodity,

X_6 = previous year's price of the related commodity and

X_7 = the change-in-taste variable.

Equation 8 involved First Differences of all variables each of which was interpreted as in the basic form (equation 5). The delta (Δ) indicates the first difference between two successive years, for example,

$$\Delta \log X_1 = \log X_{1t} - \log X_{1t-1}$$

Numerical results of the preliminary tests are given in Table V and formed the basis for comparison, evaluation and final selection. K values indicate the calculated levels of autocorrelation while the r_{ik} coefficients ($i = 1...n$; $k = 2...n$) indicate significant correlations between variables.[8]

Selection of the model used was by a process of elimination as follows:

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[8]It was thought unnecessary to include insignificant correlations.

Equation 6 was rejected because autocorrelation was strongly positive for each commodity, with calculated K values less than the lower critical values stipulated at given levels of probability. In addition, the following variable-combinations were significantly correlated: beef price and disposable income; price of beef and price of pork; disposable income and price of pork (Table V).

The method of Partial First Differences (equation 7) was generally acceptable in terms of autocorrelation. It was however rejected because of the prevalence of significant intercorrelation between the variables as designated in Table V. With the method of complete First Differences (equation 8) autocorrelation was in general within acceptable limits, with respect to the critical values stipulated. Price of beef and disposable income were significantly correlated but only at the five per cent level.

On basis of the above findings equation 8 was deemed the most satisfactory and was consequently chosen as the form on which the study was conducted. In addition to the empirical results (presented in Table V) indicating the validity of total First Differences, the method gives adequate consideration to year-to-year similarities and dissimilarities in movements. The elasticities computed are therefore likely to be within very close proximity of their true values.

Statistical predictions were made on basis of the demand functions derived, each from a different set of independent variables. The following criteria were used as guiding principles in selecting the function on which to predict:

a. levels of statistical significance of the regression coefficients.

b. levels of statistical significance of the multiple coefficient of

TABLE V

RESULTS OF TESTS OF AUTOCORRELATION AND MULTICOLLINEARITY, BASED ON DATA FOR BEEF AND PORK, CANADA, 1926-62[a]

Equation	Commodity	Autocorrelation	Multicollinearity
6	Beef	$K = 0.8242$[b]	$r_{12} = .736^{**}$; $r_{13} = .754^{**}$; $r_{23} = -.560^{*}$
6	Pork	$K = 1.0790$[b]	$r_{13} = .754^{**}$; $r_{23} = .736^{**}$; $r_{12} = -.560^{*}$
7	Beef	$K = 2.0853$[c]	$r_{14} = .935^{**}$; $r_{26} = .800^{**}$; $r_{46} = .678^{*}$
7	Pork	$K = 1.8564$[c]	$r_{15} = .627^{*}$; $r_{35} = .783^{**}$; $r_{36} = -.789^{**}$; $r_{46} = .725^{**}$; $r_{56} = -.682^{*}$
8	Beef	$K = 1.7789$[c]	$r_{12} = .603^{*}$
8	Pork	$K = 2.2162$[c]	$r_{23} = .603^{*}$

[a]Source: Computed. Omitting the years 1940-46.

[b]denotes positive autocorrelation.

[c]denotes tolerable level of autocorrelation.

**indicates significance at the one per cent level.

*indicates significance at the five per cent level.

determination (R^2).

c. the number of independent variables included.

d. the amount of departure of estimated consumption ($\hat{Y}$) from actual consumption (Y) shown graphically (Appendix B).

The basic assumption was that the rate and direction of change in population growth, disposable income and commodity prices prior to 1962 would continue between 1962 and 1970. This implicitly assumes that technological changes will continue to be greatest in some areas of production and that the overall increase in supply will be commensurate with the consequently lowered prices, at least until 1970. This implies that there will be no undue pressure arising from increased bidding-up of resources for food production.

The Method of Analysis

Multiple Regression analysis based on "least squares"[9] was employed. The validity of this method has been noted by Foote, for example, in his showing that the application of regression to time series data produces reliable estimates of direct and cross elasticity coefficients.[10] The single equation approach was deemed adequate after examining the findings and comments of major contributors to demand theory. Working discovered, for instance, that the simultaneous approach does not provide more reliable demand elasticities in a majority of cases.[11] Additional support to the validity of the single equa-

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[9]The method used to estimate the basic coefficients ("a" and "b") in order to obtain the best fit to the data. By minimizing the sum of squared deviation a linear and unbiased estimate of the dependent variable is usually obtained.

[10]Richard J. Foote, Analytical Tools for Studying Demand and Price Structures, Agricultural Handbook, No.146, United States Department of Agriculture, Agricultural Marketing Service, Washington D.C., August 1958, p.88.

[11]E.J. Working, "Progress in the Study of Demand for Farm Products", Journal of Farm Economics, American Farm Economics Association, Vol. 37, Part II, 1955, p.971.

tion method is demonstrated in Klein's Mongrel Function analysis.[12] A demand relation over time represents a continuum of equilibrium between supply and demand. In static analysis the demand curve is traced out if shifts in supply are dominant, and demand characteristics may be estimated with quantity dependent on price. The method of simultaneous equations is more applicable where supply and demand are assumed dynamic in nature.

Regression analysis is applicable where there is reason to suspect "cause and effect" in a functional way between or among variables. In demand studies, for instance, it has been shown that the quantity of a good demanded is functionally related to prices and incomes. The apparent "cause" variables (prices and incomes in this case) are designated independent variables while the "effect" variable (quantity demanded) is the dependent variable. Regression analysis attempts to examine closeness of relationships in a statistical sense by indicating the proportions of variability in the dependent variable which are explained or unexplained by the independent variables.

By way of illustrating the regression technique, assume that average milk consumption (Y) is dependent upon the price per unit of milk (X). In this simplified case, the relationship may be expressed in the following algebraic model:

$$Y = f(X)$$

A set of hypothetical observations, plotted graphically, forms a scattergram as in Figure VIa. The relationship may be illustrated alternatively by means of a regression equation of the form:

$$Y = a + bX + e$$

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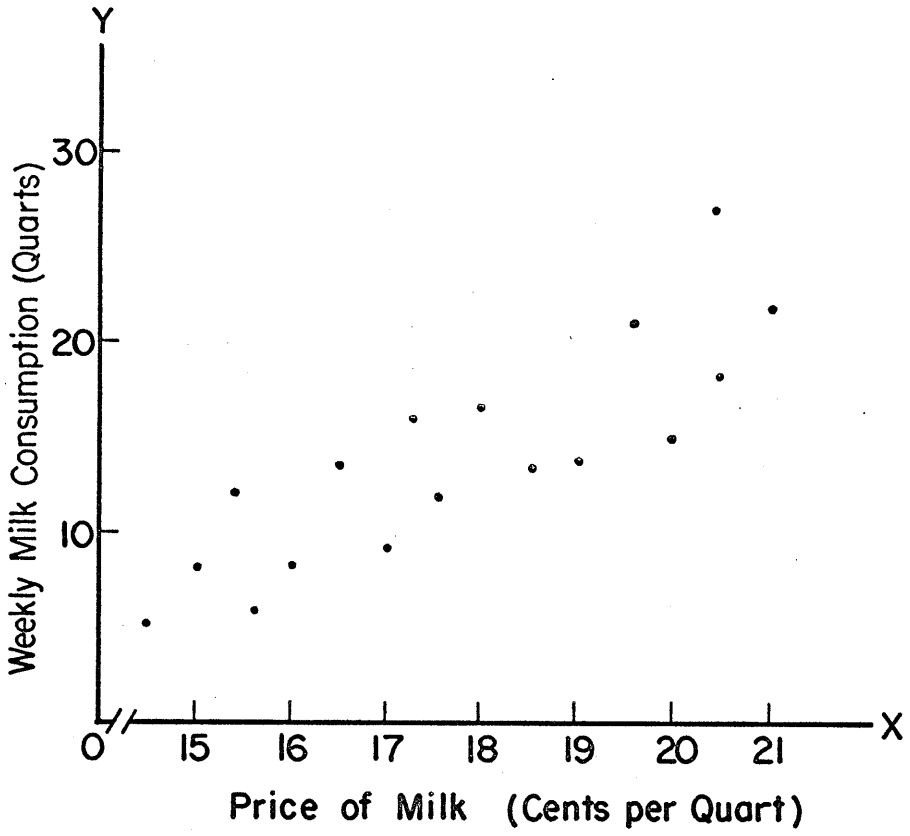
[12] Lawrence R. Klein, An Introduction to Econometrics, Prentice Hall, Inc., New Jersey, 1962, pp.8-18.



Scattergram of Weekly Milk Consumption and Retail Price of Milk (Hypothetical).

Fig. VIa.

where X and Y are milk prices and average milk consumption respectively; "a" is a numeric constant indicating average consumption of milk at zero price; "b" is the regression coefficient or slope of the line showing the marginal change in milk consumption per unit change in price; "e" symbolizes unexplained error or residual arising from faulty observation and measurements and the effect on consumption of variables other than price.

The appropriate regression line to the data may be statistically estimated from the scatter and is illustrated by DF in Figure VIb, where the equation is $Y = a + bX + e$. The true relationship may take the form $Y = \alpha + \beta X + \varepsilon$ represented by TG in the figure. True error (ε) and residual (e) are shown at any point by their departure from their respective regression lines. That is, $Y_i - \hat{Y}_i = e_i$ where Y is the observed occurence, $\hat{Y}$ the estimated, and e_i = the residual ($i = 1$ to n). This is illustrated at S in Figure VIb where is the distance from S to the true regression line and e is the distance from S to the estimated regression. The parameters $\alpha, \beta,$ and ε are estimated by the statistics a, b, and e. True error (ε) cannot be observed and is governed by some qualifying assumptions.[13]

Simple regression refers to a cause and effect relationship with one independent variable. Where there are more than one independent variables, as in the present analysis, Multiple regression is the appropriate operational technique. This implies that in multiple regression, changes in the dependent variable are ascribed to the influence of more than one independent variables acting individually or in concert.

The relationship in Figure VIb depicts a case where the regression coefficient is constant at each point on the line. A relationship so characterised is termed linear in description of the regression equation and the appropriate regression line fitted. In comparison to the linear relationship

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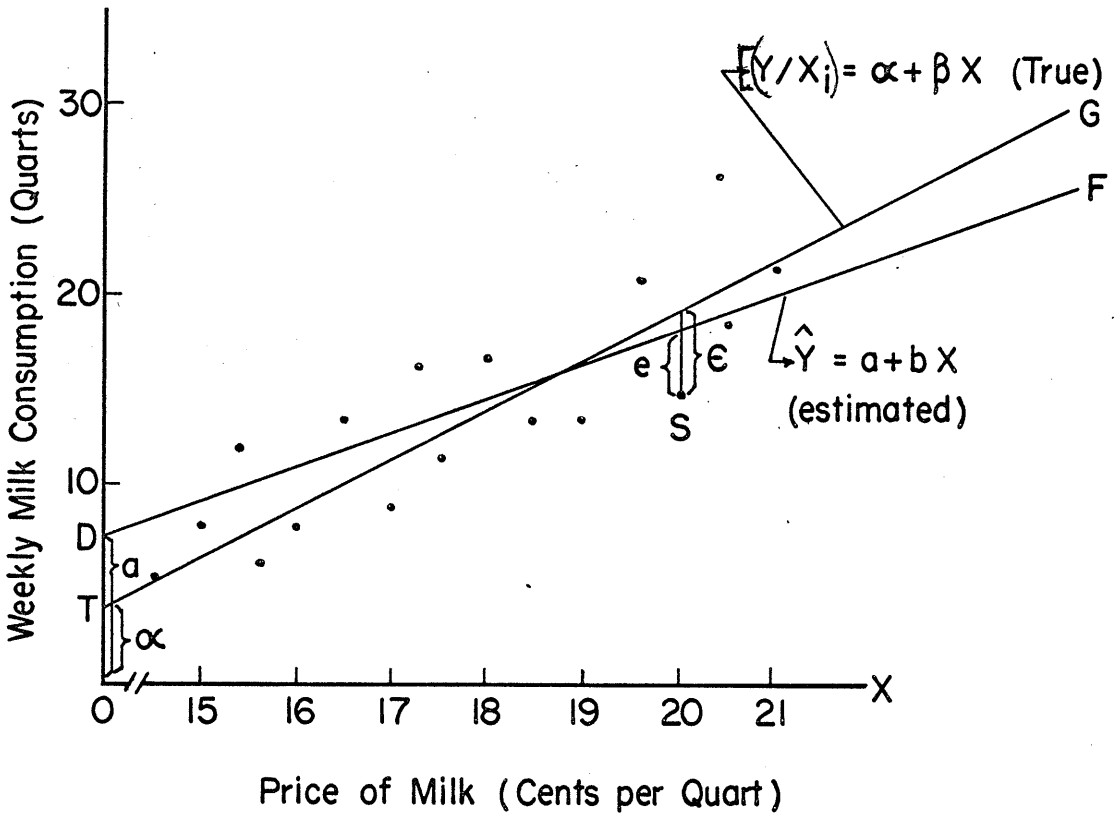
[13] S. Valavanis, Econometrics, McGraw Hill Book Company, Inc., New York, 1959, pp. 9 - 17.



Relationship Between True and Estimated Regression Lines Fitted to Scattergram (Hypothetical).

Fig. VI b.

there are those which assume curvilinear forms.[14]

Regression analysis was first applied to controlled experiments because it was possible for observations to be made independently of one another. By controlling extraneous factors and concentrating on main influences, interdependence among variables offered no serious obstacle to obtaining reliable resulsts. The method was adopted in the social sicences where most prevailing factors are not subject to control. Consequently, the tenet of complete independence among variables is never fully realized, with the result that biased and unrealiable estimates are likely.

Early investigators doubted the validity and applicability of regression analysis in the social sciences. In particular, they questioned the realism underlying the assumption that observations are from a definite and unchanging universe.[15] It was observed that no universe was ever observed to be so static since human characteristic traits were constantly undergoing changes. In the absence of human intervention it was observed that forecasts were based on the assumption that the past rate and degree of change would continue in the future. With the social sciences so characterized by purposeful intervention, such a continuum was never certain and projections were invariably faulty.

In general, dissatisfaction with regression analysis was centred mainly around: choice of approrpriate regression, bias due to faulty observations, innate problems with time series data, and complications due to simultaneous

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[14]See for example, Albert E. Waugh, Elements of Statistical Method, Third Edition, McGraw-Hill Book Company, Inc., New York, 1952, pp. 340-382.

[15]See for example, G. U. Yule, "Why Do We Sometimes Get Nonsense Correlation between Time Series?" Journal of the Royal Statistical Society, Vol. 89, No. 1, 1926, pp. 1-64.

relationships.[16]

The problems associated with time series data have already been discussed in an earlier section. As regards the other issues: It was observed that, in absence of definite empirical evidence each of several variables could be treated as dependent and that with each treatment, different regressions were obtained. This possibility now appears trivial since in every experiment the researcher's objectives and a priori knowledge of causal forces make it possible to identify and isolate the most pertinent causal variable. Because cause and effect are not readily isolated in the social sciences as they are in the more exact sciences where adequate control is possible, justification must be reached either from experience or by theoretical inference.

In controlled experiments the randomisation principle which neutralizes the effects of uncontrolled influences is used to reduce correlation between error and causal variables. Extraneous factors in the social sciences are largely uncontrollable and tend to pose problems for empirical research. In any analysis it is customary to include only those regressors whose influences, as judged by experience and a priori knowledge, are believed to be most dominant. This is in effect the Proximity Theorem which is justified on grounds that (a) regression attempts to give only a theoretical explanation, in which case, meaningful simplicity is permissable and (b) data are available for only a limited number of these extraneous factors.[17]

Errors in observed data promote disturbance in the analysis since

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[16] H. Wold, and L. Jureen, op. cit., p. 28.

[17] Ibid., p. 37.

independent variables must then fail to explain all the variation in the dependent variable. The biasing effects of error should be corrected prior to analysing the data. Special formulae and other adjusting techniques have been recommended to counteract departures from the optimum.[18] With the necessary adjustments carried out, it is shown that regression analysis leads to unbiased estimates of basic coefficients, for example: $\beta \doteq b$.[19]

Simultaneous relationships are necessary in demonstrating a system of moving equilibrium. In addition to computational difficulties there are problems of identification in order to ensure unique estimates. Simultaneous relationships are justified by the argument that any point on a scatter comprising quantities and prices is in effect a point of equilibrium between supply and demand. Continual simultaneous shifts in demand and supply are responsible for the spread of the scatter and serve as a guide in performing and interpreting the analysis.

Most of the uncertainty about and criticism of regression analysis has now been clarified and resolved. Important findings and disclosures have fostered revitalized dependence on time series regression, in particular.[20] Validity of the method is ensured and is supported by Wold for example as follows:

> The traditional methods of regression are essentially sound and much of the confusion around the controversial issues can be re-

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[18] See for example, H. Wold and L. Jureen, op. cit., equation (2), p.38.

[19] J. Johnston, Econometric Methods, McGraw-Hill Book Company, Inc., New York, 1963, pp. 108-109.

[20] M. Ezekiel and K. A. Fox, op. cit., p. 328.

moved by bringing out more explicitly the basic logical principles behind the regression methods. In demand analysis, at least, it can still be safely recommended.[21]

[21] H. Wold and L. Jureen, op. cit., pp. 29 and 59.

CHAPTER V

INTERPRETATION AND EVALUATION OF STATISTICAL RESULTS

This chapter provides and evaluates national demand functions derived by the method of least squares, utilizing first differences in the Cobb-Douglas form of equation. Empirical results are presented for red meats, poultry and eggs, dairy products, fats and oils, beverages, starches, cereals and vegetables, for the period 1926-62. The years 1940-46 were omitted because of abnormal price conditions resulting from the influences of World War II. In those instances where price and/or consumption data were lacking for all or a part of the pre-war period, the analyses were based on the post-war period alone. Also, there were instances in which data for the post-war period were reported as of 1949 onwards, as exemplified in the case of some vegetables. The period analysed in such cases was from 1949 to 1962. A change-in-taste variable was included in the analysis of those commodities for which data were available from 1926-60.

Red Meats

Included in this category are beef and veal, pork and lamb. Different analyses were performed with a view to determining the direct and indirect economic relationships between red meats and other important food groups. The results of these analyses are given in equations 6.1, 6.2, 6.3, and 6.4, of Table VI. Standard errors of the individual regression coefficients are given in parenthesis.

Equation 6.1 shows that the mean regression coefficient (elasticity) for the weighted price of red meats (X_1) is -.48. This indicates that with a one per cent increase in the weighted price of red meats, ceteris paribus,

TABLE VI

PRICE, INCOME AND GROSS ELASTICITIES[a] FOR RED MEATS AND POULTRY MEAT, CANADA, 1949-62

Equation	Commodity		Constant	Weighted Real Price Red meats X_1	Real Disposable Income X_2	Weighted Real Price Poultry meat[b] X_3	Weighted Real Price Cereals[c] X_4	Weighted Real Price Dairy[d] X_5	Weighted Real Price Beverages[e] X_6	Weighted Real Price Vegetables[f] X_7	Real Price White Potatoes X_8	R^2	S
6.1	Red Meats	(Y_1)	.988	-.483** (.153)	.351# (.270)	-.150# (.099)						.580*	.009
6.2	Poultry Meat	(Y_2)	.983	-.641# (.448)	1.120# (.807)	-1.063** (.302)						.579*	.026
6.3	Red Meats	(Y_3)	1.000	-.438* (.172)	.125 (.317)		.121 (.173)			.050 (.137)		.511	.010
6.4	Red Meats	(Y_4)	.995	-.432+ (.169)	.346+ (.336)	-.074 (.138)	.226# (.159)	-.418++ (.421)	-.093++ (.095)	.074 (.126)	.017 (.031)	.846#	.008

[a] The following levels of significance were used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent.

[b] Indicates chicken meat and turkey meat.

[c] Includes wheat flour, rolled oats, pot and pearl barley etc.

[d] Includes milk, butter and cheese.

[e] Includes coffee and tea.

[f] Includes tomatoes, cabbage, celery, lettuce, carrots, onions.

per capita consumption of red meats decreases by about .5 per cent. The positive income elasticity of .35 indicates that consumption of red meats increases as disposable income increases, and provides empirical evidence that red meats may be classified as normal goods.

There are indications that red meats and poultry meat are complementary. This observation is borne out by the cross elasticities of -.150 and -.641 in equations 6.1 and 6.2. The coefficient -.150 indicates that if the weighted price of poultry meat increases one per cent, per capita consumption of red meats may be expected to decrease by about .15 per cent, assuming other variables constant. On the other hand, a similar proportionate increase in the weighted price of red meats may decrease consumption of poultry meat by as much as .6 per cent. These negative cross relationships between red meats and poultry meats indicate that the weighted prices of both groups of meats move in the same direction.

The regression coefficient -1.063 in equation 6.2, suggests that consumer demand for poultry meat is elastic. As retail prices change one per cent, consumption changes more than proportionately. Furthermore, the b_2 coefficient shows that income elasticity of poultry meat consumption is elastic since changes in consumption of poultry meat in response to income changes are more than proportionate to the changes in incomes. The multiple coefficients of determination (.580 and .579, with standard errors of .009 and .026 respectively) were both significant at the five per cent level. These suggest that the independent variables considered accounted for only about 58 per cent of the variability in red meat and poultry meat consumption.

The observation of complementarity may be contradictory to the traditional belief that red meats and poultry meats are substitute commodities.

However, the very partial nature of the analyses, occasioned by the inclusion of a restricted number of independent variables, makes it impossible to categorically reject the possibility of substitution between these two groups.

Equation 6.3 shows that if the weighted price of poultry meat is omitted and those of cereals and vegetables included, the proportion of explained variation in consumption of red meats decreases from .580 to .511. This reduction in R^2 indicates that the weighted price of poultry meat (equation 6.1) has a greater influence on red meat consumption than the weighted prices of cereals and vegetables, introduced simultaneously (equation 6.3). The amount of scatter about the regression line is increased as indicated by a slightly higher standard error of .010, compared with the previous .009.

Equation 6.3 also shows that while demand elasticity decreases only slightly in magnitude and level of significance (from .48 to .43) the decrease in income elasticity is more pronounced (from .35 to .12). Although not statistically significant even at moderate levels, the income elasticity of .125 again indicates a tendency for red meat consumption to increase with increases in disposable incomes.

There are indications of economic independence between cereals and red meats and between vegetables and red meats, as demonstrated by the small but positive cross elasticities of .121 and .050 respectively. The insignificance of the coefficients with comparatively high standard errors serve to mask the possibility of a clear and definite relationship between these commodities. On the basis of the statistical evidence obtained, therefore, the economic relationships between cereals and red meats and between vegetables and red meats remain indeterminate.

Equation 6.4 shows the results obtained when other independent variables were introduced into the analysis. The proportion of variability in

red meat consumption explained by these variables is not only significant but substantially increased. The multiple coefficient of determination (.846) indicates that only about 15 per cent of the variability in red meat consumption remained unexplained. The standard error of estimate (.008) is evidence that most of the observations fall along the line of regression and hence, indicates a "good fit" of the data.

With the usual ceteris paribus assumption, further observations may be made from equation 6.4. These may be enumerated as follows:

1. The relationship of complementarity between red meats and poultry meat as indicated previously in equations 6.1 and 6.2 may not be stated with any degree of certainty, in view of the small and insignificant b_3 coefficient with its standard error of .138. Lack of significance could be a genuine reflection of the lack of a true economic relationship. It may also be due to the limited number of observations and to a reduction in the degrees of freedom caused by the introduction of additional independent variables. Whether there be substitution or complementarity between red meats and poultry meat, the implication in each alternative is that a given one per cent change in the price of poultry meat may have a practically imperceptible effect upon the quantity of red meats bought.

2. Because of statistical insignificance and standard errors greater in magnitude than the regression coefficients themselves, no definite statement may be made regarding the economic relationship between red meats and vegetables and between red meats and potatoes, on basis of the statistical results obtained. The relationship as indicated in the equation might be positive or negative, thereby indicating independence.

3. Substitutability has been significantly demonstrated in the case of red meats in relation to cereals, although this cross relationship is indicated only at a moderate level of significance.

4. The mean regression coefficient of the weighted price of red meats is slightly in excess of .43 and compares favourably with those presented in equations 6.1 and 6.3.

5. Income elasticity of red meats is positive and approximates .35.

6. There are indications of slight complementarity between dairy products and red meats and between beverages and red meats, as demonstrated by the moderately significant cross elasticities of -.418 and -.093 respectively. With a one per cent increase in the weighted price of dairy products, the amount of red meats purchased or consumed decreases by about .4 per cent. A similar price change in beverages may cause red meat consumption to change by only .1 per cent.

Economic theory states that as the number of independent variables in an analysis is increased, the resulting coefficients become more realistic, since real market price situations are more closely approximated. In this light, the elasticities presented in equation 6.4 may be regarded as demonstrative of the market being investigated, on basis of available data.

Important economic relationships between individual foods may be concealed if analysis is confined merely to food groups. Table VII presents results for individual meats, with a view to elucidating the inter-relationships between them.

Individual Meats

Beef:

Demand elasticity for beef is slightly in excess of -.3 as given in equation 7.1. This is an estimate of relative inelasticity and indicates that a one per cent increase in beef price may decrease beef consumption by about .3 per cent. The effect of income changes on beef consumption has not

TABLE VII

PRICE, INCOME AND CROSS ELASTICITIES[a] FOR BEEF[b], PORK, LAMB AND CHICKEN MEAT, CANADA, 1949-62

Equation	Commodity		Constant	Real Price Beef X_1	Real Disposable Income X_2	Real Price Pork X_3	Real Price Chicken X_4	Real Price Lamb X_5	Weighted Real Price Red Meats X_6	Weighted Real Price Wheat Flour X_7	Real Price Potatoes X_8	Weighted Real Price Vegetables X_9	R^2	S
7.1	Beef	(Y_1)	1.001	$-.311^{+}$ (.509)	.188 (.242)	$.358^{\#}$ (.260)	.134 (.651)	-1.201^{*} (.446)					$.854^{*}$	.026
7.2	Pork	(Y_2)	1.038	.177 (.508)	-1.429^{++} (1.544)	$-.662^{*}$ (.293)	.251 (.670)	.161 (.556)					.522	.035
7.3	Lamb	(Y_3)	1.037	-.027 (.431)	-.888 (1.309)	.057 (.249)	$.514^{++}$ (.567)	-1.784^{**} (.472)					$.781^{*}$	.030
7.4	Chicken Meat	(Y_4)	.963	$-.690^{+}$ (.376)	$1.651^{\#}$ (1.141)	$-.316^{\#}$ (.217)	-1.352^{*} (.494)	$.474^{++}$ (.411)					$.680^{+}$	.026
7.5	Chicken Meat	(Y_5)	.991		1.134^{++} (.653)		$-.785^{*}$ (.323)		-.137 (.418)	$-.552^{*}$ (.357)	.034 (.071)	$-.374^{++}$ (.277)	$.841^{*}$	.020

[a]The following levels of significance were used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent.

[b]Includes beef and veal.

been significantly demonstrated by the b_2 coefficient (.188). The cross relationships expressed by the b_3 and b_5 coefficients of the equation suggest that beef is substitutable with pork but is complementary with lamb. A definite economic relationship between beef and chicken meat has not been established due to the insignificant b_4 coefficient with its comparatively high standard error (.651). Relative dependability of the coefficients is suggested by the high proportion (over 85 per cent) of variability in beef consumption explained by the independent variables considered.

Pork:

The mean price elasticity for pork (-.662) in equation 7.2 indicates that pork consumption may be more sensitive to price changes than is beef consumption. A one per cent change in pork price may significantly decrease its consumption by as much as .6 per cent. In spite of greater responsiveness to price changes the mean elasticity coefficient for pork is less than unity. The positive signs preceding the cross elasticities between pork and beef, pork and chicken meat and between pork and lamb indicate slight degrees of substitutability between pork and each of the other meats. In a statistical sense, however, these relationships are not significant and are therefore inconclusive, on basis of the empirical evidence obtained. Pork consumption decreases significantly as disposable incomes increase. This tendency, the major characteristic of inferior goods, is indicated by the negative income elasticity of 1.429 (equation 7.2).

The variables analysed left a considerable proportion, about 48 per cent, of the variability in pork consumption unexplained. The comparatively high standard error of .035 indicates variation in excess of acceptable magnitudes, about the regression line fitted.

Lamb:

Consumer demand for lamb is highly elastic, with a mean elasticity coefficient of -1.784 (equation 7.3). The size of this coefficient illustrates a tendency for lamb consumption to change more than proportionately to a given change in price. Lamb appears to be substitutable with chicken meat. The relationships between lamb and beef and between lamb and pork appear to be very slight and may not be clearly identified from the empirical results. As is the case with pork, lamb consumption appears to decrease with increases in disposable income. The degree of sensitivity to income changes is not significant even at moderate levels but is comparatively smaller than that for pork. The multiple coefficient of determination and the standard error of estimate indicate that more than 75% of the variability in lamb consumption is explained by the real price of lamb, real disposable income and real prices of beef, pork and chicken meat.

Chicken Meat:

Statistical results for chicken meat, evaluated in relation to individual red meats, are given in equation 7.4. Chicken meat is highly and significantly elastic, with respect to changes in disposable income and its own price. In the presence of other meats, income elasticity in excess of unity and an inverse price quantity relationship may be expected. The positive and significant income elasticity indicates that chicken meat may not be regarded as an inferior good. Chicken meat is complementary with beef and pork. This observation shows that while beef and pork might be substitutable with chicken meat as indicated in equations 7.1 and 7.2, the relationship is not necessarily true of chicken meat in respect to beef and pork. There is a completely reversible relationship of substitution between chicken meat

and lamb, at slightly varying magnitudes.

Inclusion of some additional variables in the analysis of demand for chicken meat resulted in a better fit to the data as may be ascertained (in equation 7.5) from the large increase in the coefficient of determination and a reduction in the standard error of estimate. Demand for chicken meat appears to be significantly inelastic instead of significantly elastic. Income elasticity remains significant and in excess of unity. The relationship between chicken meat and red meat and between chicken meat and potatoes has not been made clear by the cross coefficients obtained. Complementarity is significantly shown between chicken meat and wheat flour and, to a lesser extent, between chicken meat and vegetables.

In general, the cross elasticities in Table VII indicate that the magnitude of substitution or complementarity between commodities may not be stated with any degree of definiteness in a number of cases. It may be seen that even where relationships are significantly demonstrated, the relationships may not be fully reciprocated. For example, by comparing the estimates .358 and .177 for beef and pork in equations 7.1 and 7.2, beef tends to be a better substitute for pork than pork is for beef. Chicken meat is complementary with beef while the relationship from the opposite direction (between beef and chicken meat) may not be clearly identified. Complementarity is more clearly marked between beef and lamb than between lamb and beef. There has been no statistical evidence of a definite relationship between lamb and pork, as indicated by the coefficients in equations 7.2 and 7.3.

Eggs

In the discussion which follows, consumer demand for eggs is evaluated in relation to closely related foods in breakfast and pastry uses.

Data availability for the entire period made it possible to examine the trend in consumer preference for eggs. The empirical results, illustrating consumer demand for eggs, are presented in Table VIII.

Equation 8.1 is based on a five-variable relationship. These variables are: real price of eggs (X_1), disposable income (X_2), real price of bacon (X_3), consumer preference (X_4)[1] and per capita egg consumption as the dependent variable (Y_1).

The highly significant and inverse relationship of -.31 between egg consumption and the retail price of aggs is indicative of an inelastic demand for eggs. That is, with a one per cent change in the price of aggs, the quantity demanded changes less than proportionately, that is, by about .3 per cent. An income elasticity of .37 indicates that eggs are normal goods and may show significant changes in the amount consumed, in response to income changes. The relationship between bacon and eggs has not been clearly supported on basis of the empirical evidence provided by the coefficient. It is indicated by the b_8 coefficient that consumer preference for eggs, although relatively stable, has been increasing slightly.

Cross relationships between egg consumption and most of the independent variables coincided with the postulated effects of the variables. For example, observation of market behaviour gives support to this inverse price relationship. As incomes increase consumers are enabled to utilize eggs in more varied forms. Increased purchasing power may stimulate greater egg consumption, and perhaps improve the nutritional value of foods consumed.

Although less than 50 per cent of the variation in egg consumption

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[1] Expressed as X_8 in Table VIII, for convenience.

TABIE VIII

PRICE, INCOME AND CROSS ELASTICITIES[a] FOR EGGS, CANADA, 1926 - 60

Equation	Commodity		Constant	Real Price Eggs X_1	Real Disposable Income X_2	Real Price Bacon X_3	Weighted Real Price Dairy X_4	Weighted Real Price Beverages X_5	Real Price Bread X_6	Real Price Potatoes X_7	Change in Preference X_8	R^2	S
8.1	Eggs	(Y_1)	.995	-.310** (.084)	.369** (.164)	-.014 (.047)					Increase	.406*	.015
8.2	Eggs	(Y_2)	.995	-.305** (.084)	.380* (.173)		-.002 (.143)				Increase	.403*	.015
8.3	Eggs	(Y_3)	.993	-.306** (.095)	.379+ (.090)	-.008 (.063)	-.093 (.324)	.026 (.118)	-.175 (.237)	-.021 (.032)	Increase	.435	.017

[a]The following levels of significance were used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent.

was accounted for, the coefficient of determination (.406) with a standard error of .015 was significant at the five percent level.

Equation 8.2 shows the results when dairy products (X_4= the weighted price of milk and butter) are introduced as a composite related commodity. These results are close to those obtained in equation 8.1. Demand and income elasticities of -.30 and .38 respectively are inelastic and are further evidence that a one per cent increase in the price of eggs may reduce egg consumption by about .3 per cent, while a similar increase in disposable income may result in increased egg consumption of the magnitude of about .38 per cent. Similarly, the trend in preference for eggs, the R^2 and S values are comparable to those in equation 8.1. With a cross elasticity of -.002 and a standard error of .143, no definite relationship may be established between dairy products and eggs.

In the final analysis presented in equation 8.3, beverages (coffee and tea), bread and potatoes are introduced as variables which may have important influences on egg consumption. These additional variables are designated X_5, X_6 and X_7 in the table. Demand and income elasticities of -.30 and .38 again indicate the inelasticity of egg consumption in response to price and income changes. The inverse price quantity relationship and positive income elasticity are also evident. Economic relationships between eggs, bacon, dairy products, beverages, bread and potatoes have not been made conclusive even at moderate levels of significance.

By introducing these additional variables, the coefficient of determination and the standard error of estimate were increased in magnitude. Nonsignificance of the coefficient of determination as well as of many of the elasticity coefficients may be expected, by virtue of the limitations imposed

by loss of degrees of freedom, caused by the increase in the number of independent variables.

Dairy Products, Fats and Oils

Dairy Products

In addition to analysing demand for dairy products as a composite commodity, analyses were conducted for the individual components as well. In one instance the composite comprises whole milk, cream and butter. This made it possible to evaluate consumer preference since price and consumption data were available for the entire period. In another instance, the analysis was based on whole milk, cream, butter and cheese consumption 1949-62, since price data for cheese were not reported for the preceding period. The analysis for butter was similarly restricted because of limitations imposed by the unavailability of price data for margarine, a commodity closely related (in use) to butter. Empirical results for dairy and its individual components are presented in Table IX(a).

It was hypothesized that the commodities most closely related to dairy products are: cereal products, red meats, bread and beverages (coffee and tea). The prices of these, in addition to disposable incomes and the weighted price of dairy products, were expected to explain most of the variability in the consumption of dairy products.

Substitutability and complementarity between dairy products and other foods may be associated with purchasing pattern as well as with actual consumption. For instance, whole milk, cream and butter may be complementary with cereal products in breakfast and pastry uses. On the other hand, consumers might assess the economic feasibility of buying more dairy products instead of meats, and vice versa, in light of market situations.

TABLE IX (a)

PRICE, INCOME AND CROSS ELASTICITIES[a] FOR DAIRY PRODUCTS, CANADA 1926-62 ; 1949-62

Equation	Commodity	Constant	Weighted Real Price Dairy Products X_1	Real Disposable Income X_2	Weighted Real Price Cereals X_3	Weighted Real Price Red Meats X_4	Real Price Bread X_5	Weighted Real Price Beverages X_6	Real Price Whole Milk and Cream X_7	Real Price Butter X_8	Real Price Margarine X_9	Real Price Cheese X_{10}	Real Price Eggs X_{11}	Change in Preference X_{12}	R^2	S
9a.1	Dairy Composite (Y_1)	.987	-.047 (.217)	.065 (.141)	$-.195^{*}$ (.071)									Increase	$.331^{+}$	.013
9a.2	Dairy Composite (Y_2)	.984	-.012 (.189)	.306 (.144)	$-.079^{++}$ (.072)	$.357^{\#}$ (.290)	.015 (.047)								.527	.004
9a.3	Whole milk & cream (Y_3)	.989		.139 (.156)	$-.134^{++}$ (.129)	$-.300^{\#}$ (.201)	.020 (.097)	$-.474^{++}$ (.403)						Increase++	$.303^{\#}$	.014
9a.4	Butter (Y_4)	.944		$.860^{+}$ (.428)		$-.934^{++}$ (.916)				$-.152^{++}$ (.172)	.089 (.173)		$-.091$ (.107)		$.412^{\#}$	.012
9a.5	Cheese (Y_5)	.991		$.708^{++}$ (.607)		$1.731^{\#}$ (1.322)						$-.712^{++}$ (.811)			.206	.060

[a]The following levels of significance were used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent.

The b_1 and b_2 coefficients in equation 9a.1 indicate that changes in consumption of dairy products (whole milk, cream and butter) are not significantly related to changes in disposable income or its own weighted price. In absence of statistical significance and with standard errors of .217 and .141, price and income elasticities for this composite may be expected to fall between - .170 and .264 and between -.076 and .206, respectively. The relatively low estimates of price and income elasticities obtained indicate that consumers might be consuming these commodities in approximately the same rate at which they are desired, and so, the effects of price and income changes are not marked.

Complementarity between dairy and cereal products is indicated by the negative and significant b_3 coefficient (-.195). This result illustrates the tendency for consumers to curtail purchases or consumption of whole milk, cream and butter by about .2 per cent, in response to a one per cent change in the weighted price of cereals. There has been a positive change in consumer preference for whole milk, cream and butter, as a composite.

The demand function implicit in equation 9a.2 relates to the aggregate of whole milk, cream, butter and cheese. In addition to their weighted price and disposable incomes, prices of red meats, bread and beverages were considered causal variables in the consumption of dairy products. The coefficient -.012 shows a negative but insignificant price quantity relationship for diary products. Income elasticity is positive and in addition, statistically significant. The income elasticity coefficient (.306) indicates that increases in disposable incomes may be expected to promote increased consumption of dairy products to a magnitude of about .3 of a given relative income change. Red meats and dairy products appear to be complementary, as

shown by the significant and negative cross coefficient .079 in equation 9a.2. The appearance of complementarity between these commodity groups may be expected since a change in the price of one is likely to be reflected in the price of the other, in a similar direction. Substitutability between bread and dairy products, as shown by the .357 coefficient may best be explained in terms of choice during purchase. If the price of bread increases, consumers might be induced to purchase more of dairy products with a view to increase home baking. The cross elasticity of .015 between dairy products and beverages (coffee and tea), although positive, is not significant and in this regard, may not be used to specify an economic relationship.

Consumer demand for whole milk and cream, butter and cheese, taken individually, may be described as inelastic, since the magnitude of the elasticity coefficient is significant in each case and indicates less than a proportionate quantity response to a given price change. With a price elasticity of -.712 demand for cheese appears to be the least inelastic. On the other hand, butter tends to be the most inelastic, with a coefficient of -.152. When contrasted with cheese and butter, demand for whole milk and cream is intermediary.

Income elasticity is positive for butter and cheese. Income changes do not seem to significantly affect consumption of whole milk. These relationships may be determined from the b_2 coefficients in equations 9a.3, 9a.4 and 9a.5. The implication is that consumption of butter and cheese increases as disposable incomes increase. Of the three commodities cited above, butter may be expected to exhibit the largest income-quantity response. Next, in order, are cheese and whole milk.

Red meats and bread are complementary with whole milk and cream (equation 9a.3). There is no real evidence of the true relationship between beverages and whole milk.

Equation 9a.4 shows that the traditional belief of substitution between butter and margarine has not been supported by the empirical evidence at hand. On the other hand, bread is complementary with butter, as shown by the negative and significant cross elasticity of .934. The b_5 coefficient in equation 9a.5 indicates that with a given increase in the price of bread, consumers increase their consumption of cheese more than proportionately. Substitution between bread and cheese may be more meaningfully explained in terms of purchasing behaviour rather than actual consumption.

With the exception of the relationship presented in equation 9a.2 less than 50 per cent of the variability in consumption of dairy products was explained, in spite of relatively low standard errors. This might be due to weaknesses of the model itself, to omission of the more pertinent variables or to possible inaccuracies in the data.

Fats and Oils:

The items selected in this group are margarine, lard and shortening. Empirical results for these are presented in equations 9b.6, 9b.7 and 9b.8.

Margarine:

With a one per cent increase in disposable income, consumption of margarine decreases by more than one per cent. This observation is implied in the negative b_2 coefficient, in excess of unity. Furthermore, margarine exhibits a positive price quantity relationship, the magnitude of which is indicative of a highly inelastic demand for the commodity. These characteristics of price and income elasticities serve to confirm the traditional

TABLE IX (b)

PRICE INCOME AND CROSS ELASTICITIES[a] FOR FATS AND OIL PRODUCTS, CANADA, 1949-62

Equation	Commodity	Constant	Real Price Margarine X_1	Real Disposable Income X_2	Real Price Butter X_3	Real Price Bread X_4	Real Price Lard X_5	Real Price Shortening X_6	Real Price Wheat flour X_7	R^2	S
9b.6	Margarine (Y_6)		.246^{++} (.232)	-1.091$^{\#}$ (.695)	.260^{++} (.288)	-1.016* (.524)				.601*	.021
9b.7	Lard (Y_7)	1.054	.727$^{\#}$ (.561)	-1.849* (1.028)			-.938** (.229)	1.365* (.514)		.733*	.035
9b.8	Shortening (Y_8)	1.002		-.498 (.344)			.198^{+} (.114)	-.564^{+} (.326)	-.351^{++} (.360)	.469$^{\#}$	.022

[a]The following levels of significance were used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent.

belief that margarine is an inferior good. There is evidence of substitution between margarine and butter, as shown by the positive cross coefficient .260. With margarine a substitute for butter, the complementary relationship between bread and margarine may be expected.

Lard and Shortening

Lard may similarly be termed an inferior good in view of its negative income elasticity. A similar relationship has been indicated for shortening but cannot be stated with any degree of definiteness, owing to a lack of statistical significance. The significant and larger estimate (-1.849) for lard indicates that inferiority is greater than in the case of shortening.

Consumer demand for lard is less inelastic than that for shortening. A given increase in the price of lard may be expected to reduce its consumption almost proportionately, whereas with shortening, consumption may be reduced by about .6 of the relative price change. Lard appears to be a good substitute for margarine and shortening. This observation is implied by the b_1 and b_6 coefficients in equation 9b.7. Shortening is less of a substitute for lard than lard is for shortening.

There is evidence of complementarity between shortening and wheat flour. This relationship is expected in view of their joint use in baking and other forms of cookery.

From Tables IX(a) and IX(b) it may be observed that a considerable proportion of variability in consumption of dairy, fats and oil products were unexplained by the variables selected, although in the majority of cases the multiple coefficient of determination (R^2) estimates were statistically significant. Judging from the R^2 values it may be assumed that there is only

a moderate degree of confidence that the dependent variables fell close to their respective regression lines. This may be particularly true in regard to whole milk, butter and cheese consumption and may be attributed to limitations imposed by the data, the model, or the choice of causal variables.

Beverages and Refined Sugar

Although the study aimed primarily at analysing consumer demand for agricultural commodities produced nationally, it was observed that certain imported items rank highly on the list of preferred foods in Canada and were therefore qualified for statistical investigation. Examples of such imported foods are coffee, tea and sugar. Empirical information regarding consumer demand for these staples might aid in directing or regulating their importation and domestic distribution.

Table X shows that the total value of coffee, tea and sugar imported into Canada reached a high of nearly 189 million dollars in 1957. Although there has been a decline in total value since then, the amount spent abroad on these commodities is sufficiently substantial to warrant investigation into their economic characteristics. Furthermore, it appears from mere observation that these items occupy a important position in the domestic commercial market.

The statistical results for beverages and sugar are presented in Table XI.

Coffee:

The negative price quantity relationship for coffee was anticipated. Short-run increases in the price of coffee might induce consumers to purchase less coffee, since other forms of beverages are easily obtained. Numerical coefficients in equation 11.1 show that:

(a) with a one per cent increase in the price of coffee, consumption

TABLE X

TOTAL VALUE OF COFFEE, TEA AND SUGAR IMPORTS INTO CANADA, 1954-62*
(MILLION DOLLARS)

Year	Value of Coffee	Value of Tea	Value of Sugar	Total Value
1954	67.7	23.8	62.8	154.3
1955	61.7	25.8	65.5	153.0
1956	72.4	24.8	69.7	166.9
1957	71.5	24.4	92.9	188.8
1958	67.2	23.0	76.3	166.5
1959	59.6	23.1	74.7	157.4
1960	56.6	23.6	70.1	150.3
1961	59.3	24.0	72.5	155.8
1962	62.2	22.5	74.4	159.1

*Source: Canada Year Books: 1957-58, 1959, 1960, 1962, 1963.

of coffee may be curtailed by about .3 per cent. (b) income elasticity (.227) of coffee is positive but well below unity and provides inconclusive evidence that coffee consumption increases as disposable incomes increase. (c) substitutability and or complementarity between coffee and tea and between coffee and sugar has not been clearly demonstrated by the coefficients .279 and -.185. (d) there has been a positive change in consumer preference for coffee.

Tea:

The effect of a given price increase on per capita consumption of tea is roughly comparable in magnitude to that of coffee. Equation 11.2 indicates the tendency for a decrease in tea consumption of about .25 per cent

TABLE XI

PRICE, INCOME AND CROSS ELASTICITIES[a] FOR BEVERAGES,[b] AND REFINED SUGAR, CANADA 1926-62

Equation	Commodity		Constant	Real Price Coffee X_1	Real Disposable Income X_2	Real Price Tea X_3	Real Price Sugar X_4	Weighted Real Price Beverages X_5	Weighted Real Price Dairy[c] X_6	Real Price Starches[d] X_7	Change in Preference X_8	R^2	S
11.1	Coffee	(Y_1)	1.084	-.277^{++} (.255)	.227 (.248)	.279 (.385)	-.185 (.264)				Increase	.114	.057
11.2	Tea	(Y_2)	1.006	.208 (.335)	.352 (.421)	-.258 (.507)	-.135 (.347)				Decrease	.060	.074
11.3	Refined Sugar	(Y_3)	1.013	.049 (.085)	.176^{++} (.183)	.180$^{\#}$ (.129)	-.270* (.088)				Increase	.415*	.019
11.4	Beverages	(Y_4)	1.014		.231^{++} (.211)			-.327* (.145)	-.125 (.309)	.049 (.093)	Increase	.264	.015

[a]The following levels of significance were used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent

[b]Includes coffee and tea.

[c]Includes fluid milk and butter.

[d]Includes potatoes and wheat flour.

in response to a one per cent increase in the price of tea. Income elasticity (.352) is positive but not statistically significant and appears to be greater than that for coffee. The implication is that a given increase in disposable income may or may not increase tea consumption. Nonsignificance of the regression coefficients together with their comparatively high standard errors precludes specificity with regard to the economic relationships between tea and coffee and between tea and sugar.

Consumer preference for tea has been on the decline as indicated by the b_9 coefficient.

Sugar:

Consumption of sugar is significantly influenced by price changes. The significant price elasticity (-.270) indicates that the change in consumption of about .3 per cent in response to a one per cent change in price, may not be attributed to chance or random behaviour patterns. Income elasticity of sugar (.176), although of low magnitude, is both positive and significant and suggests that deliberate or planned influences may be the reason why changes in sugar consumption correspond in direction with changes in disposable incomes. Indications are that more sugar is consumed as the prices of coffee and tea increase. This tendency is conclusive with tea but not with coffee, as indicated by the b_1 and b_3 coefficients.

All beverages:

Statistical results for the demand of beverages (coffee and tea) in relation to other groups of foods are given in equation 11.4. In addition to the weighted price of beverages (X_5), disposable income (X_2) and change in consumer preference (X_9), the other variables deemed causal in beverage consumption are: the weighted prices of dairy products (X_6) and starches (X_7).

On basis of the results the following observations may be made: (a) there is a significant and negative price quantity relationship for beverages as a composite. With a one per cent increase in the weighted price of beverages, consumption of these commodities decreases by about .3 per cent. (b) income elasticity of beverages, although low in magnitude, is positive and significant, (c) the cross relationships between beverages, dairy products and starches tend to be relatively low and indeterminate. There are very slight indications that, as the weighted price of dairy products increases by one per cent, beverage consumption may be decreased by about .125 per cent. This tendency illustrates a complementary relationship in contrast to that of substitution indicated between beverages and starches by the positive but somewhat negligible coefficient (.049). In spite of these tendencies, the economic relationship between beverages and dairy products and beverages and starches may not be categorically posited, in view of the insignificant regression coefficients and relatively high standard errors. If the respective ranges are used, each of the relationships may be either one of substitution or complementarity (or complete independence).

The estimates of changes in consumer preference for coffee, tea and sugar show that preference for coffee and sugar has shifted upwards with time while preference for tea has declined slightly. With the exception of sugar, the elasticities derived might well be regarded as unsatisfactory, in terms of statistical significance. The low coefficients of determination indicated that, in most cases, less than 30 per cent of the variability in the consumption of beverages was explained. The estimates of standard error also indicate some variability about the individual lines of regression.

Starches[1] and Cereals[2]

White potatoes, wheat flour and cereal products are widely consumed, nationally. The commercial importance of these foods may be indicated by their annual per capita consumption and volume of retail sales, as shown in Table XII.

TABLE XII

PER CAPITA CONSUMPTION AND TOTAL RETAIL SALES FOR WHITE POTATOES, WHEAT FLOUR AND CEREALS, CANADA, 1955-60*

Year	Per Capita Consumption			Total Retail Sales		
	White Potatoes	Wheat Flour	Cereal Products	White Potatoes	Wheat Flour	Cereal Products
	pounds			million dollars		
1955	150.6	147.8	155.6	95.0	148.5	156.4
1956	153.3	145.1	154.8	103.0	148.6	158.5
1957	161.1	138.8	151.6	92.3	149.8	163.6
1958	135.4	142.8	145.1	84.5	156.3	158.8
1959	146.6	136.0	149.1	89.3	157.0	172.2
1960	143.6	135.2	142.6	116.4	167.0	176.1

*Source: Dominion Bureau of Statistics, Apparent Per Capita Domestic Disappearance of Food in Canada, 1955-60.

Potatoes

Equation 13.1 of Table XIII indicates that demand elasticity for white potatoes is positive and only slightly in excess of .2. The magnitude and nature of this coefficient demonstrate the positive effect of price changes on per capita consumption of potatoes. In other words, a one per cent in-

[1] Indicates white potatoes and wheat flour

[2] See footnote C of Table XIII

TABLE XIII

PRICE, INCOME AND CROSS ELASTICITIES[a] FOR STARCHES[b] AND CEREALS[c], CANADA, 1949-1962

Equation	Commodity		Constant	Real Price Potatoes X_1	Real Disposable Income X_2	Real Price Wheat flour X_3	Weighted Real Price Red Meats X_4	Weighted Real Price Dairy X_5	Weighted Real Price Vegetables X_6	Weighted Real Price All Cereals X_7	R^2	S
13.1	White Potatoes	(Y_1)	.933	$.212^{++}$ (.187)	$.418^{\#}$ (.350)	$.509^{+}$ (.309)	$-.574$ (.201)		$-.787$ (1.008)		$.545^{\#}$	.071
13.2	Wheat flour	(Y_2)	1.030	$.061^{++}$ (.061)	-1.669^{+} (.752)	$-.244$ (.426	.188 (.408)		$.548^{+}$ (.109)		$.533^{\#}$	.024
13.3	All Cereals	(Y_3)	1.030	$.102^{*}$ (.283)	-2.334^{**} (.365)		.125 (.187)	-2.476^{**} (.469)	$.323^{+}$ (.158)	$-.563^{*}$ (.202)	$.917^{**}$	.010

[a]The following levels of significance were used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent.

[b]Includes white potatoes and wheat flour only.

[c]Includes wheat flour, oatmeal and rolled oats, rye flour and meal, pot and pearl barley, buckwheat flour.

crease in the price of potatoes tends to increase the amount consumed by about .2 per cent. A fall in price, similar in magnitude, is expected to reduce the amount of potatoes consumed by about .2 per cent. Consequently, consumer demand for potatoes may be seen to be extremely inelastic. The nature of the elasticity coefficient illustrates a positive inclination of the demand function.

Income elasticity (.418) is positive and significant and suggests the tendency for consumption of potatoes to increase as disposable incomes increase. There are indications that the relationship between potatoes and wheat flour is one of substitution. This is a significant relationship and may be accepted even on a priori grounds, on basis of observed consumption patterns.

Although the cross elasticity coefficient of -.574 suggests complementarity between potatoes and red meats, this relationship is not clearly identified, due to lack of statistical significance. The implication however is that, as the weighted price of red meats increases, consumers are induced to purchase less potatoes. A similar relationship may also be shown to exist between potatoes and vegetables, as is indicated by the elasticity coefficient -.787.

Wheat Flour:

A price elasticity of -.244 indicates that demand for wheat flour is not significantly affected by changes in its own price. As shown in equation 13.2, the effect of income changes on wheat flour consumption is significantly marked. The large but negative income elasticity (-1.669) provides evidence that wheat flour is an inferior good.

Vegetables and white potatoes are substitutable with wheat flour in varying degrees although the relationships of substitution are only moderately

significant. There is no real evidence of the true relationship between red meats and wheat flour.

Cereals:

Results for all cereals, in relation to other categories of foods, in addition to disposable incomes and their own weighted price, are presented in equation 13.3. Price and income changes appear to exert highly significant effects on the consumption of cereal products. The larger and negative income elasticity compared with that for wheat flour aids in classifying cereals as more "inferior" than wheat flour alone.

The economic relationship between cereals and red meats is not clearly identified. Substitution is significantly demonstrated with respect to potatoes and vegetables. The negative and highly elastic cross relationship (-2.476) indicates complementarity between cereals and dairy products. The implication is that a given price change in dairy products will tend to change consumption of cereals by about 2.5 times the magnitude of the relative price change, in a similar direction.

More than 90 per cent of the variability in cereal consumption is explained by the independent variables considered, as shown by the multiple coefficient of determination (.917). In addition, the relatively low standard error (.010) indicates a small amount of scatter about the regression line, thereby providing a satisfactory fit of the data. The statistical results obtained for potatoes and wheat flour are less satisfactory, when viewed in terms of the proportion of explained variability. In either case, less than 60 per cent of the variability in consumption is explained. This might be a feasible explanation for the comparatively high standard errors.

Vegetables

Vegetables are known to be a leading source of vitamins, proteins and minerals, all of which are necessary in the diets of humans. Empirical investigation into the economic interrelationships between these and other main foods (as prices and incomes increase) may aid in verifying observed consumption patterns and in signifying important economic tendencies, useful to agriculturists, business and consumers.

Statistical results of the various demand relationships for vegetables are presented in Table XIV. The results tend to be somewhat unsatisfactory, because of the only moderately significant elasticities, the low magnitudes of the coefficients of determination and the relatively high standard errors. In spite of these weaknesses however, there are important tendencies which warrant an economic evaluation.

Consumption of vegetables considered as a group, does not appear to be significantly affected by changes in the weighted price of vegetables. This is indicated by the fact that the coefficient, -.457, is not significant even at moderate levels. With a standard error of .346, a negative price quantity relationship may be regarded dominant if the interval $-.457 \pm .346$ is adopted.

Income elasticity of vegetables is positive, moderately significant and greater than unity and suggests that as disposable incomes increase, consumers tend to increase the quantity of vegetables consumed, more than proportionately. There are no clear indications of complementary relationships between vegetables and red meats and between vegetables and starches. About 90 per cent of the variability in the consumption of vegetables is unexplained and the standard error (.061) indicates some scatter about the line of regression.

TABLE XIV

PRICE, INCOME AND CROSS ELASTICITIES[a] FOR SELECTED VEGETABLES, CANADA, 1949 - 1962

Equation	Commodity		Constant	Weighted Real Price Vegetables X_1	Real Disposable Income X_2	Weighted Real Price Red Meats X_3	Weighted Real Price Starches X_4	Real Price Tomatoes X_5	Weighted Real Price Other Vegetables X_6	Real Price Onions X_7	Real Price Potatoes X_8	Real Price Cabbage X_9	Real Price Celery X_{10}	Real Price Lettuce X_{11}	Real Price Carrots X_{12}	R^2	S
14.1	Vegetables	(Y_1)	1.044	-.457 (.346)	1.685^{++} (1.927)	-.149 (.066)	-.123 (.357)									.104	.061
14.2	Tomatoes	(Y_2)	1.041		1.139^{+} (1.051)			.157 (.639)	-.211 (.719)							.079	.066
14.3	Onions	(Y_3)	.994		-.221 (.848)				.071 (.348)	-.050 (.151)	-.016 (.093					.097	.025
14.4	Cabbage	(Y_4)	1.000		-1.055^{++}				.529$^{\#}$ (.383)		.017 (.074)	.031 (.176)				.234	.028
14.5	Celery	(Y_5)	.977		.880^{++} (.935)				-.339 (.415)				-.133 (.220)			.126	.030
14.6	Lettuce	(Y_6)	1.075		2.092* (1.083)				.456^{++} (.434)		.031 (.082)			-.292^{++} (.250)		.506$^{\#}$	.032
14.7	Carrots	(Y_7)	1.093		.968^{++} (.659)				.498 (.335)		.031 (.172)				-.533 (.886)	.135	.070

[a]The levels of significance were as follows: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent.

Lettuce and carrots appear to be the most sensitive to price changes. This tendency is significantly demonstrated in the case of lettuce. The positive price quantity relationship exhibited by tomatoes and cabbage are of small magnitudes and are not statistically significant. In general, the individual price elasticities indicate that demand for vegetables is highly inelastic and that price changes do not significantly affect their consumption.

Tomato, cabbage and lettuce consumption is income elastic. The price substitution effect in each case is largely out-weighed by the income effect. The negative income elasticity for cabbage indicates that this commodity may be deemed inferior since, as incomes increase, its consumption is curtailed. A similar relationship appears to exist for onions but the statistical evidence is less clear. On the other hand, tomatoes, celery, lettuce and carrots may be classified as normal goods since their consumption increases with an increase in disposable incomes. This tendency is significantly demonstrated in each case. There are indications that while consumers tend to increase consumption of celery and carrots less than proportionately to a given income increase, the opposite is true for tomatoes and lettuce when incomes increase.

Although not supported by statistical significance, there is a tendency for the prices of tomatoes and celery to move in a similar direction with the weighted price of other vegetables. In other words, consumption of tomatoes and celery might be complementary with that of other vegetables. These relationships are indicated by the negative coefficients in the X_6 column of Table XIV. Further indications are that as the weighted price of other vegetables increase, consumption of onions, cabbage, lettuce and carrots also increase. This result suggests a relationship of substitutability particularly in the cases of cabbage and lettuce, in that consumption of these

vegetables may be expected to increase when the weighted price of other vegetables increases.

The low and insignificant b_8 coefficients do not clearly indicate complementarity or substitutability between potatoes and the individual vegetables given in equations 14.3 to 14.7 of Table XIV. In view of these deficiencies the economic relationships involved between these commodities may not be specified or generalized, on the basis of the empirical results.

Of the various categories of foods analysed in this chapter, the results obtained for vegetables tend to be the most unsatisfactory. Reliability of many of the regression coefficients may be questioned from the point of view of statistical insignificance from which some degree of indefiniteness emerges. In the majority of cases, the proportion of variability in consumption explained by the independent variables tends to be disappointingly low. The standard errors of estimate for individual vegetables appear to be highest among the groups analysed. Indications are that there has been a poor fit of the data to the respective lines of regression.

The causes of these unsatisfactory results may be determined by additional empirical analyses. In attempting to bring about improvements in the estimates, consideration may be given (a) to the possibility of modifying the model used in this investigation, (b) to the use of another basic model, or (c) to a consideration of other independent variables deemed important and pertinent. It appears that the analytical mechanism adopted in this investigation fails to be sufficiently powerful and effective in clearly isolating the economic relationships among vegetables.

CHAPTER VI

STATISTICAL PREDICTIONS AND THEIR IMPLICATIONS FOR CANADA

In this chapter demand functions selected from the tabular results in Chapter V will be used as bases for predicting demand for selected agricultural commodities in Canada.

It was realized that errors might arise from initial failure to include some relevant variables in the derivation of the demand functions and that these errors may seriously detract from meaningful predictions. In the extreme case, they may completely invalidate any claim to congruence with reality and usefulness. The longer the period to be forecasted, the more vulnerable to criticisms will be the projections, as a result of the cumulative effects of errors. In recognition of this, projections in the present investigation are made for a relatively short period of eight years; that is, from 1962 to 1970.

Criteria For Selecting Demand Functions

The empirical results for red meats, poultry meat, chicken meat, eggs and diary presented in Chapter V, were given by two or more demand equations, each derived from a different combination of causal variables. It was necessary, for purposes of prediction, to select from each category that function which most closely approximates actual demand relationships, in order to provide a dependable basis on which to predict. In doing so, some definite criteria were used as aids to final selection. These criteria may be enumerated thus:

a. the number of causal variables involved in the analysis.

In most cases, greater credence was given to those functions having the largest number of independent variables. This was based on the economic

postulate that confidence in statistical estimates is enhanced as the number of independent variables is increased, since actual market situations are more closely approached.

b. levels of statistical significance of the elasticity coefficients. More confidence was attached to the more highly significant coefficients.

c. in some cases it was difficult to evaluate the various demand functions on basis of number of independent variables and levels of statistical significance. For example, a problem arose when two functions consisted of an equivalent number of variables in which incidences of significance or nonsignificance were roughly comparable. In such cases, evaluation was carried out on basis of the size and statistical significance of the multiple coefficient of determination (R^2) and the standard error of estimate (S).

Since R^2 value gives the approximate proportion of variability in the dependent variable accounted for by the independent variables analysed, the function with the highest R^2 value was selected particularly if there were even moderate levels of significance attached. The standard error of estimate gives an idea of dispersion about the line of regression. The smaller the standard error of estimate, the greater is the degree of congruence between the estimated and true regressions. Further support was obtained by examining the closeness of fit between actual and estimated consumption as shown graphically.[1] Relationships showing the least amount of divergence between actual and estimated values may be expected to be more reliable for prediction purposes.

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[1]See the graphs illustrating actual and estimated consumption for the different categories of food in Appendix B.

The Basic Assumptions

The forecasts made were based on the following assumptions:

1. that the observed rate of change in the basic parameters prior to 1962 is maintained during the interval 1962-70.

2. that there are no sudden economic and technological changes or political and social upheavals to interfere seriously with the relatively smooth operation of the economic mechanism.

With these assumptions having been made, it is possible to attach confidence and reliability to the predicted values, ceteris paribus, since the trends and corresponding algebraic equations may be regarded as representative and reliable bases for predictions.

Statistical Predictions

Table XV presents a summary of annual per capita consumption for various foods and food groups for Canada from 1926 to 1962 (omitting 1940-46), with projections to 1970. The basic equations are selected from Chapter V on basis of the qualifying criteria outlined previously.

In 1962 total population in Canada was approximately 18.6 million persons with real disposable income per capita of 1156.9 dollars. It is projected that by 1970 total population will have increased to about 22 million and real disposable income per capita to approximately 1325 dollars. These estimates represent anticipated increases slightly in excess of 18 per cent and 14.5 per cent respectively.

Red Meats

It is estimated that if population, disposable incomes, prices and consumer tastes continue to change on the average as they did during 1947 to

TABLE XV

PER CAPITA CONSUMPTION OF SELECTED FOODS, WITH PROJECTIONS TO 1970, CANADA*

Commodity or Commodity Group	Unit	Basic Equation	Average 1926-39	Average 1947-51	Average 1952-56	Average 1957-61	Average 1962	Projection for 1970	Change in Domestic Requirements 1962-1970[a]
Red Meats[b]	lbs.	6.4	118.3	132.0	136.6	139.8	138.5	165.7	41.7
Beef	"	7.1	61.0	65.5	74.2	76.0	76.4	85.0	36.0
Pork	"	7.2	48.8	53.8	49.7	50.9	49.9	56.9	35.0
Lamb	"	7.3	5.7	2.9	2.4	3.0	3.8	4.7	46.5
Poultry Meats	"	6.2	11.1	16.5	22.6	28.5	32.6	42.0	55.0
Chicken meat	"	7.5	—	15.0	20.6	22.5	31.0	41.0	57.4
Eggs	doz.	8.1	23.1	20.3	23.4	26.7	35.6	45.9	52.7
Whole Milk and Cream	lbs.	9a.3	397.5	411.5	396.1	393.5	385.3	377.1	16.0
Butter	"	9a.4	30.3	23.7	20.7	18.1	16.4	8.8	-36.4
Cheese	"	9a.5	3.9	5.6	6.5	8.2	8.6	16.6	128.7
Coffee	"	11.1	3.2	6.1	7.1	8.9	9.0	13.2	74.0
Tea	"	11.2	3.7	3.3	2.9	2.5	2.4	1.8	-11.2
Sugar (refined)	"	11.3	89.2	97.6	96.3	96.0	97.0	89.4	9.2
Margarine	"	9b.6	—	5.3	7.7	9.0	10.1	18.9	121.6
Lard	"	9b.7	—	9.5	8.5	8.6	7.2	6.6	8.6
Shortening	"	9b.8	7.7	9.6	9.5	9.3	9.0	8.1	6.6
White potatoes	"	13.1	216.1	155.1	147.2	143.2	164.0	148.0	7.0
Wheat flour	"	13.2	177.6	153.6	145.3	137.7	132.6	126.2	10.0
Cereals	"	13.3	188.4	161.0	152.2	144.3	139.3	131.1	11.7

*Source: Computed from Handbook of Agricultural Statistics, D.B.S., Ottawa.

[a]Percentage change in aggregate consumption.

[b]Includes offals and canned meats, in addition to beef and veal, pork and lamb.

1962, per capita consumption of red meats may be expected to increase from 138.5 pounds (1962) to about 165.7 pounds in 1970. On basis of these predictions, total red meat consumption may be expected to be about 3.6 billion pounds in 1970; an increase of approximately 42 per cent over the total consumed in 1962. With a standard error of estimate of .008 it is reasonable to expect about 99 per cent of the error to fall between .024 and -.024. In this light, total consumption of red meats in 1970 is projected to be between 3.6 and 3.7 billion pounds.

The anticipated increase in red meat consumption appears to be substantial, considering the relatively short period, and could have far-reaching implications on the volume of domestic meat production, possible changes in importance of geographic areas of production and processing, domestic and export prices. In order to bring about the necessary adjustments as smoothly as possible, consideration should be given to present and potential locational patterns of production and processing. If previous projections on meat production in Canada are correct, by 1970 the Prairie Provinces should be producing the greater proportion of Canada's cattle and hogs. For example, MacFarlane and Black have estimated that by 1970 about 67 per cent of the cattle and more than 50 per cent of the hogs will be produced in the Prairie Provinces.[2] In light of recent developments it may be doubtful that these projections will materialize, because of the incentives offered to cereal grain production on the Prairies by the substantial increase in foreign demand for Canadian grains, and present prospects of a continuing

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[2] D.L. MacFarlane and J.D. Black, The Development of Canadian Agriculture to 1970, MacDonald College, McGill University, 1958.

trend in this direction for some time.

With a price elasticity of -.43 and an income elasticity of .35 it is anticipated that changes in the weighted price of red meats may be a greater deterrent to red meat consumption than changes in disposable incomes, at least in the short run. This observation is borne out by the fact that, as a rule, prices change more often during a given period than do incomes. The underlying causes of these changes may be attributed to a complex set of factors the most important of which are: available and anticipated supply, technological innovations, political and social changes, trends in consumer tastes, etc. Because income changes occur less often they are more predictable and, therefore, may contribute to fuller adjustments by consumers. Another possible inference is that red meats have assumed a definite and important position in the budgets of Canadians, to the extent that, the effect of incomes on red meat consumption may not be markedly demonstrated.

A limited amount of competition with red meats may be expected from the other major food groups analysed. Although alternative sources of proteins may be sought when red meat prices increase relatively to other prices, a major competing food group has not been identified. Competition from vegetables and potatoes appears uncertain but cereal products could exert some limited influence.

Quality improvement and more competitive prices on the world market could aid in improving Canadian external trade in red meats while at the same time benefitting domestic consumption. Table XVI shows that imports of beef and veal, mutton and lamb into Canada were far in excess of exports of these commodities in each of the years from 1959 to 1963. Between 1959

and 1962 pork exports were in excess of imports. However in 1963 the volume of pork imports rose to more than three times that of the previous year and was more than twice that of pork exports.

TABLE XVI

IMPORTS AND EXPORTS OF RED MEATS, CANADA, 1959-63*
(Thousand pounds)

Year	Beef and Veal		Pork		Mutton and Lamb	
	Imports	Exports	Imports	Exports	Imports	Exports
1959	49,068	22,378	68	42,467	20,119	715
1960	29,083	17,987	11,476	35,881	23,532	75
1961	41,183	29,033	28,677	34,400	33,436	139.8
1962	45,317	19,726	23,635	35,814	37,916	518.8
1963	49,230	17,228	76,899	34,199	48,063	644.4

*Source: Forty-fourth Annual Livestock Market Review, Department of Agriculture, Ottawa, Canada, pp. 45, 45a.

With the facilities available for feed grain production, technology and access to markets, the high import rate of red meats into Canada could be reduced and discouraged by careful planning and government aids toward accelerated domestic production.

Beef:

In 1962 total beef consumption was slightly in excess of 1.4 billion pounds, with an annual per capita consumption of 76.4 pounds. On basis of an income elasticity of .2 for beef, predicted population, real disposable income and price movements, it is expected that by 1970 total beef consumption will have reached 1.9 billion pounds or an annual per capita consumption of 85 pounds. Pork and chicken meat will continue to be the major competitors of

beef. Anticipated increase in total consumption of beef from 1962 to 1970 will be about 36.0 per cent.

Pork:

Average annual consumption of pork for the 1947-51 period was about 716 million pounds. By 1962 the total amount consumed increased to approximately 928 million pounds, an increase of about 30 per cent over the 1947-51 average. Projected pork consumption for 1970 is roughly 1.25 billion pounds or approximately 56.9 pounds per capita. These estimates are based on the income elasticity (-1.429) for pork and the anticipated increases in population and disposable incomes. The amount of pork consumed nationally in 1970 is expected to increase by about 35 per cent over domestic consumption in 1962, due to the projected population in 1970.

The predicted increase in per capita pork consumption appears questionable because of the highly negative income elasticity and anticipated increases in disposable incomes. This peculiar phenomenon is explained by the effects of other variables as follows:

a. price elasticity for pork is in excess of -.6. In presence of a declining trend in the real price of pork up to 1970, consumption of this commodity is expected to increase markedly.

b. there are indications of substitution between pork and beef, and between pork and lamb. The increasing price trends for these meats, particularly beef, up to 1970, are also expected to bring about increased pork consumption.

In a word, it is possible that the effect of pork prices in conjunction with those of related red meats may outweigh the negative income effect, thereby supporting the validity of the predicted increase in pork

eggs between 1949-61 indicates the relative importance of these products among Canadians (Table XVII). Total consumption of poultry meats increased annually between 1949-62, with the exception of 1953 and 1960. Chicken meat comprised the greatest proportion, with turkey, goose and duck occupying a less prominent role, probably as specialty foods. The increase in egg consumption has been marked by annual fluctuations since 1955.

Poultry Meats:

Several factors may be responsible for the apparent increase in poultry meat consumption. Among them may be mentioned:

1. The falling trend in poultry price indexes since 1949. The decrease is at a much faster rate than that for red meats. Relative price differences might be important in inducing increased consumption of poultry meats.

2. There have been remarkable innovations in the poultry industry. Of particular importance are mass production, evisceration, improved feeds and feeding methods, development of more efficient breeds which have resulted in comparatively lower unit cost of output in the industry. A proportion of the economies secured at the production and processing stages are passed on to the retail stage in the form of lower prices to consumers.

3. An apparent increase in preference for poultry meats. In addition to the price factor there are other important attributes deemed responsible. First, chicken meat is as a rule softer in texture than red meats and for this reason might be more appealing to a larger cross section of all age groups. Second, improved merchandizing techniques have resulted in making poultry meats available in more attractive and ready-to-cook forms than previously. The relative ease of preparing chicken meat and the variety

TABLE XVII

ANNUAL PER CAPITA CONSUMPTION OF POULTRY MEATS AND EGGS, CANADA, 1949-62*

Year	Fowl and Chicken	Turkey	Goose and Duck	Total	Real Price Index of Poultry	Eggs	Real Price Eggs (¢)
	--------pounds eviscerated -------				(1949=100)	------dozen --------	
1949	12.9	2.5	.4	15.8	100	19.3	61.5
1950	13.2	2.5	.4	16.1	93.6	19.7	54.9
1951	15.0	2.6	.4	18.0	99.6	19.7	63.0
1952	17.9	3.4	.4	21.7	86.5	21.1	50.7
1953	15.9	3.5	.4	19.8	94.0	22.7	58.5
1954	16.6	4.7	.4	21.7	82.4	24.3	49.1
1955	18.9	5.0	.4	24.3	80.5	23.8	52.8
1956	19.2	6.0	.4	25.6	77.6	24.3	53.5
1957	19.4	6.1	.5	25.9	72.2	25.4	45.9
1958	21.1	6.0	.5	27.6	69.7	24.8	46.2
1959	22.0	7.9	.5	30.4	62.5	23.3	43.0
1960	20.9	6.4	.5	27.8	63.2	23.0	42.6
1961	23.2	7.6	.6	31.4	56.9	36.7	43.6
1962	--	--	--	32.6	56.3	35.6	40.7

*Sources: Handbook of Agricultural Statistics, D.B.S., Ottawa; Canada Packers Ltd., Annual Report, 1964.

of ways in which it may be prepared, particularly at a time when the proportion of females in the labour force is increasing, may also be a major contributing factor.

On the basis of past trends in prices, disposable incomes and population, it is predicted that per capita consumption of poultry in 1970 will approximate 42 pounds, with about 924 million pounds as the national total. This represents a predicted increase of roughly 55.0 per cent over the total consumed in 1962 and 30.5 per cent on a per capita basis. Per capita consumption of chicken meat alone is expected to increase from 31.0 pounds in 1962 to about 41.0 pounds in 1970; that is, an increase of about 33 per cent. Of the predicted total consumption in 1970 chicken meat will represent slightly more than 90 per cent.

Requirement of chicken meat on a national scale is expected to increase by as much as 57.4 per cent.

Table XVIII shows the amount spent on imported poultry meats between 1957 and 1962[3]. The import-export comparison categorizes Canada as a net importer of poultry meats with the United States as the sole source of importation.

Canadian producers will be faced with continued competition from the United States in view of their ability to produce and market at lower prices as a result of greater economies in breeding, production and processing. Unless Canadian output is expanded, efficiency increased and local quality made comparable at competitive prices with those imported (in absence of governmental embargo on imports), the trend will be towards con-

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[3]Dominion Bureau of Statistics, Trade of Canada, Imports and Exports by Countries, Volumes 1957 to 1962.

tinued and greater imports.

TABLE XVIII

VALUE OF POULTRY MEATS, DRESSED OR UNDRESSED, IMPORTED INTO CANADA, 1957-62*

Year	Value of Exports	Value of Imports
	——dollars——	
1957	127,835	4.4 million
1958	163,390	3.8 "
1959	194,193	2.4 "
1960	87,580	7.1 "
1961	109,631	3.2 "
1962	535,708	2.8 "

*Source: Computed from Trade of Canada, Vols. 1957-62, D.B.S.

Farmers and policy makers in Canada may examine the feasibility of encouraging expansion of local poultry enterprises and of substituting poultry for enterprises now carried on, but with more limited economic potential.

With an income elasticity of 1.120 poultry consumption is expected to increase as disposable incomes increase. It has been observed however, that "only so much chicken and turkey will be bought" after a given level of income is attained.[4] It is reasonable to assume that the current pattern of poultry meat consumption will continue for some time since it is believed that the bulk of Canadians have not yet reached the given saturation level of incomes.

[4]J.T. Hill, "Trends in Per Capita Consumption of Poultry Meat in Canada", Canadian Journal of Agricultural Economics, Volume X, No.2, 1962, p.85.

Eggs:

Per capita egg consumption between 1926-39 was marked by annual fluctuations. Since 1947 there has been a rising trend in the amount of eggs consumed nationally. Retail prices for eggs, although somewhat erratic between 1949 and 1958, have been showing a decreasing trend.

Income elasticity of eggs was estimated at .369.[5] With anticipated annual increases in disposable incomes, continued increases in egg consumption may be postulated. If incomes, prices and population continue to change as predicted, total consumption is expected to increase from the 661 million dozen in 1962 to about 1010 million dozen in 1970, an increase of nearly 53 per cent over 1962. On a per capita basis, egg consumption will be about 45.9 dozen in 1970.

Between 1957 and 1960 there were favourable trade balances on eggs.[6] The export value was far in excess of that for imports of eggs. The opposite has been true since 1961 and this unfavourable balance might be the result of reduced Canadian output of eggs or increased domestic demand over local production.

Import surpluses on eggs might be insignificant in terms of total trade. It is even possible that this excess might be confined to specific areas rather than to the nation as a whole. Since they might have important economic reprecussions to individual farm firms their implications might best be explored through additional research confined to micro economic analysis.

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[5] See Chapter V, Table VIII, equation 8.1.

[6] Trade of Canada, Volumes 1957-60.

Expanded egg production in Canada might aid in lessening or eliminating the gap between the value of imports and exports and will depend mainly on government trade policy, availability of capital for expansion and establishment of poultry farms, increased technology with the view to achieving the economies on which financial success in the enterprise depend.

Dairy Products[7]

On the whole, average consumption of dairy products has been decreasing since 1947 (Table XV). This overall trend may be attributed to the rapid decrease in consumption of the major components, namely, fluid whole milk and butter.

Fluid Whole Milk:

Whole milk consumption per person increased from the prewar average of 397.5 pounds to 411.5 lbs for the 1947-51 period. A rapid rate of decrease during the 1952-56 period was followed by less spectacular declines in subsequent periods. Average consumption in 1962 was 385.3 pounds. If anticipated movements in prices, disposable incomes and population are correct, it is predicted that whole milk consumption by 1970 will be slightly in excess of 377 pounds per person. On a per capita basis this represents a fall of approximately 2 per cent. Total whole milk consumption is expected to increase from 7.2 billion pounds in 1962 to 8.3 billion pounds in 1970 (as a result of anticipated population increase), or by about 16 per cent.

A recent tendency among Canadians is to substitute skimmed milk powder for fluid whole milk.[8] This might be the reason for the relatively

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[7] Including fluid whole milk, butter and cheese.

[8] L.E. Drayton, "Markets for Canadian Agricultural Products," Canadian Journal of Agricultural Economics, Volume XII, No. 1, 1964, p.25.

low rate of increase in the predicted total requirement of whole milk. It is not certain whether the change from whole milk to skimmed milk by some consumers is a permanent one. Before expenditures are made on plant and equipment with a view to satisfying consumer requirements for skimmed milk it is advisable to conduct market or consumer surveys in order to determine the nature of the change.

Butter:

Average per capita consumption of butter has shown a continuously decreasing trend since the pre World War II period (Table XV). Most of the decline has occurred since the war.

In 1962 the amount of butter consumed per person was 16.4 pounds. With a population of about 18.6 million, total consumption amounted to 304.5 million pounds. With the relevant variables considered, it is estimated that per capita consumption of butter will decrease by slightly less than one pound per year during the period 1962-70, thereby reaching a level of 8.8 pounds in 1970. This represents a reduction of nearly 50 per cent in per capita butter consumption and about 36 per cent in the total amount consumed nationally.

The reduction in per capita consumption of butter up to 1962 may be partly attributed to consumer emphasis on curtailed fat intake. Also, consumers might regard butter as a relatively expensive product when compared with margarine and other spreads.

It is difficult to predict the trend in butter consumption in light of the recent lowering of wholesale butter prices. With butter having a price elasticity of -.15 it is anticipated that price reduction will be a minor factor in stimulating marked increases in consumption of this product. Much will depend on consumer consciousness and avoidance of high fat-content

foods. If it is true that lower prices are ineffective in accelerating domestic consumption, an alternative might be to lower the export price of butter thereby expanding exports on a price discrimatory basis to present importing countries where demand for the product is comparatively more elastic. In addition, new markets may be sought with a view to avoiding further stock-piling and giving incentive and greater security to producers.

Cheese:

Although the real price of cheese has been relatively constant since 1949, per capita consumption has shown a distinctly upward trend. From an average consumption of 3.9 pounds during the 1926-39 period, cheese consumption in 1962 increased to 8.6 pounds per person with a total consumption of 159.7 million pounds. If changes in the basic variables are as predicted, cheese consumption may be expected to increase by about one pound per person annually; that is, to approximately 16.6 pounds per capita in 1970. In other words, on a per capita basis, a 93 per cent increase in cheese consumption is predicted between 1962 and 1970. This estimate is fairly consistent with the 100 per cent increase predicted by Drayton for 1980.[9] At the 1970 predicted rate of consumption the total amount of cheese for consumers' requirement will be approximately 365 million pounds, an increase of 128 per cent.

Canadian cheese manufacturers might examine the feasibility of gradually acquiring the facilities for expanded cheese production. With some enlargement of herds and the tendency among consumers to shift from fluid whole milk to skimmed milk, the basic ingredient required should be

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[9] Ibid.

adequately provided. A promising and potentially lucrative venture might be that of expanding or initiating the manufacture of those cheese varieties presently imported.

Beverages[10] and Refined Sugar

Coffee:

Since 1926 there has been an increasing trend in coffee consumption. The largest increase occurred immediately after the second world war, that is, during the 1947-51 period, in spite of increasing coffee prices.

Per capita coffee consumption in 1962 was only about one per cent higher than the average for 1957-61 (Table XV). On the basis of postulated changes in the relevant variables, it is predicted that in 1970 the amount of coffee consumed per person will have increased by about 36 per cent. That is, coffee consumption in 1970 is projected at 13.2 pounds per person or slightly more than 290 million pounds nationally. On a national basis, the total amount of coffee consumed will increase by roughly 74 per cent between 1962 and 1970.

Tea:

Unlike coffee, average per capita consumption of tea has been decreasing fairly steadily. From a high of 3.7 pounds during the pre-war period, average consumption declined to 2.4 lbs in 1962. The reduction in average tea consumption may be partly attributed to the comparatively high and continuously increasing trend in the retail price of tea. Another contributing factor might be Canadians' decreasing preference for tea.

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[10] Includes coffee and tea.

The decrease in average tea consumption at the time when coffee consumption is expanding would indicate that Canadians have been substituting more and more coffee for tea. This observation, however, remains a conjecture since the relationship of substitution between these commodities was not statistically established in the analytical study.

About 44.6 million pounds of tea was consumed in 1962. It is predicted that national tea consumption in 1970 will have decreased to about 39 million pounds with a per capita intake of 1.8 pounds.

Refined Sugar:

Canadians have been becoming increasingly conscious of their caloric intake. In spite of falling sugar prices up to 1961 there was a slight reduction in average sugar consumption. The phenomenal increases in sugar prices during 1963-64 may result in further drastic curtailment in sugar consumption.

On basis of an income elasticity of .17 for sugar, and the postulated continued trend in prices, disposable income and population, it is predicted that sugar consumption will continue to fall and that the amount per person in 1970 will be about 89.4 pounds, a decrease of approximately 8.5 per cent from the average amount consumed in 1962. On a national basis total consumption in 1970 (1.97 billion pounds) will be about 9.2 per cent higher than the amount consumed in 1962 (1.80 billion pounds), due to the predicted population increase.

Sugar is probably one of the most widely used ingredients in food preparations industrially and in homes. Canadian policy makers might explore the economic feasibility of entering into the World Sugar Agreements Pact in light of Canada's weak bargaining position during periods of severe shor-

tages in traditional import areas. This might aid in reducing the degree of sugar-price flexibility and in making sugar prices in Canada more competitive and acceptable to consumers.

Oils and Fats

It is observed that the amount of margarine consumed per capita has been increasing at a time when butter consumption has been decreasing (Table XV). This inverse behaviour might be the result of a structural change from butter to margarine. Another possible cause might be the differences in relative prices of butter and margarine. Consumer response to the recently reduced butter prices may, after a time, indicate which of the two factors is the more important.

It is predicted that by 1970 per capita consumption of margarine will have reached 18.9 pounds. This estimate was made on the assumption that past trends in prices, incomes and population growth will continue.

Judging from the low but positive cross relationship identified between butter and margarine in Chapter V, a reduction in butter prices may not be expected to bring about appreciable decreases in margarine consumption. It is conceivable however, that if continued reductions are made in the price of butter while that of margarine remains unaffected, a higher and significant cross relationship between these products might be identified empirically.

Consumption of shortening has been decreasing much more slowly than that of lard (Table XV). At the same time the average retail price of shortening, since 1952 at least, has been consistently higher than that of lard. In view of empirical evidence of substitution between lard, shortening and margarine, it is suggested that consumers have been shifting from lard

and shortening to increased consumption of margarine, because of possible health and price factors.

If prices, incomes and population continue to change at their previous rate, per capita consumption of lard and shortening in 1970 will be 6.6 and 8.1 pounds respectively. At these levels, consumption on a per capita basis will have decreased 8.3 per cent for lard and 10 per cent for shortening. Total domestic requirement for lard in 1970 will approximate 145.2 million pounds, an increase of nearly 9 per cent over the total consumed in 1962. About 178.2 pounds of shortening is expected to be consumed nationally in 1970 and will represent an increase of nearly 7 per cent over the 1962 national consumption.

The implications for margarine, lard and shortening are rendered difficult of evaluation by the 1963 reduction in butter prices. Because margarine and butter are observed to be used interchangably in a variety of uses, and because margarine, lard and shortening are substitute commodities, comparatively lower butter prices, if maintained, could have indirect influences on consumption of lard and shortening and therefore may detract from the predictions posited. Whether or not butter prices return to their previous levels and are left entirely to market forces, it may be necessary for producers and processors to make necessary plans for expanded output of fats and oils, particularly margarine, since in addition to anticipated increase in domestic requirement they are also widely used for industrial purposes. In the five years immediately preceding 1962 more than 30 million dollars have been spent annually on importation of vegetable oils into Canada. [11]

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[11] Canada Year Book, Volumes 1958-63.

Expanded production of oils and fats may necessitate governmental assistance in the form of loans at low levels of interest for incentive purposes, in order to provide the raw materials, plant and equipment necessary to meet the anticipated expansion in demand.

Other Products

White Potatoes

Per capita consumption of potatoes was at a relatively high level during the pre World War II years. The average for the 1926-39 period was 216.1 pounds per person. Since the recovery from the abnormal war influences, average potato consumption per capita has shown a downward trend. Although the amount consumed per person in 1962 was slightly higher than the average for the five year period immediately preceding, there is evidence that this level of consumption might have been due primarily to year to year fluctuations.

It is predicted that potato consumption in 1970 will be as low as 148 pounds per person, representing a decrease of approximately 10 per cent on a per capita basis. On basis of the factors deemed relevant, domestic requirement in 1970 is expected to increase by about 211 million pounds over the 1962 total, that is, by about 7 per cent.

Although per capita consumption of potatoes has been declining, there are seasonal importationsof potatoes from the United States to some areas of Canada. The causes of these imports are not certain but the major possibilities might be: insufficient national production, transportation cost advantage resulting from close geographic proximity, or inferior quality of locally produced potatoes. These are factors which may be analysed by further research with a view to identifying the problems

involved and to emphasize more specifically the implications for Canada.

Wheat Flour:

The decrease in average consumption of wheat flour is less spectacular than that for potatoes. From an average of 177.6 pounds in 1926-39 the subsequent five-year averages show continuous secular declines (Table XV).

In 1962 the amount consumed per capita was 132.6 pounds. On basis of past trends in disposable incomes, prices and population, it is predicted that in 1970 per capita consumption of wheat flour will be slightly in excess of 126 pounds. Domestic requirements will however increase from 2.5 billion to about 2.8 billion pounds, because of anticipated population growth.

Canada, a leading wheat producing country with considerable stockpiled surpluses, is expected to be in a most favourable position to provide the anticipated small increase in wheat flour requirement.

Cereal Products:

Like potatoes and wheat flour, average consumption of cereal products has been declining since the pre-war years.

With an income elasticity of -.233 for cereal products and anticipated continued increase in disposable income, per capita consumption of these products is expected to decrease further over the years ahead. From the average of 139.3 pounds in 1962 per capita consumption in 1970 is predicted at 131.1 pounds, providing the trends in the main determinants continue at the same rate and in the same direction as previously.

Because of the predicted population increase total cereals consumed in 1970 will approximate 2.9 billion pounds, an increase of roughly

12 per cent over the amount consumed in 1962.

As in the case of wheat flour, Canada should experience no difficulty in providing this extra output for domestic consumption.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The basic statistics (elasticities) on which planning, forecasting and decision-making are currently conducted in the agricultural and related sectors of the Canadian economy are seriously lacking in both quantity and reliability. Researchers and policy makers have often relied on estimates derived in other countries in spite of the possibility that they are inappropriate bases for domestic planning and policy. In light of the inadequacy of basic parameters, the present investigation was undertaken with the primary aim of providing information upon which planning and control may be formulated.

More specifically the objectives of the study were:

1. To derive price, income and cross elasticities for individual edible farm products or groups of products at the retail level of marketing.

2. To predict consumption requirements of certain basic foods in 1970.

3. To cite implications for Canada, based on the elasticities derived and the forecasts made.

The following hypotheses were formulated with a view to giving a manageable dimension to the study:

1. There is a functional relationship between the quantity of a product consumed and its price.

2. There is a functional relationship between the quantity of a product demanded and personal disposable income.

3. There is a functional relationship between the prices of some

commodities and the quantities of some other commodities purchased.

In order to test the above hypotheses and to make the estimates derived as realistic as possible, it was necessary to make the following qualifying assumptions:

1. Consumers are rational and consistent in their market behaviour.

2. Retail prices and disposable incomes are the main quantifiable factors affecting per capita consumer demand.

3. The competitive structure of marketing in the pre and post-World War II periods was relatively stable.

4. Marginal propensity to consume (mpc) is less than unity and is relatively constant within any one income group. In addition, the mpc does not change within periods though it might change between periods.

5. A relatively stable demand but variable supply conditions for the commodities analysed.

National demand functions were derived for food groups and individual foods falling into the following categories: Red meats, Poultry, Cereal and Dairy products, Fats and oils, Beverages and Sugar, Starches[1] and Vegetables. Originally it was intended to include the category of fruits (imported or produced locally). After examining the short period for which price data for fruits were available it was decided to omit the entire category from the analysis.

Data analysed in the study were obtained from secondary sources, mainly Dominion Bureau of Statistics publications.

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[1] Denotes white potatoes and wheat flour.

Quantity consumed was treated as the dependent variable in each instance, on the assumption that the consumer is a veritable price taker and can very seldom, if ever, affect commodity prices by virtue of the quantities bought. Disposable income and commodity prices were deemed the most influential independent variables affecting per capita consumer demand. On this premise the independent variables chosen included price of the commodity (X_1), disposable income (X_2), prices of related foods or food groups ($X_3 \ldots X_{n-1}$) and consumer taste (X_n). It was realized that indirect factors such as changes in the value of money (hence purchasing power) and population growth cause changes in aggregate demand for foods and consequently these were included in the analysis. The effect of changes in money was removed by expressing current dollars in terms of real dollars. This necessitated deflation by a consumer price index. The indexes used were based on 1949. The effect of population growth was removed by expressing consumption data on a per capita basis.

It was necessary to arrive at a single consolidated annual price for beef and pork since the prices reported pertained to specific "cuts," like rib roast etc. Appropriate weights were obtained from Canada Packers Limited and were derived on basis of the proportion of carcass weight represented by each cut. In the case of vegetables it was necessary to convert quantity data from processed to fresh equivalents. The appropriate conversion factors were obtained from the Canada Department of Agriculture official release.[2]

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[2]See: Marketing Service, Economics Division, Canada Department of Agriculture, Canadian Weights, Measures and Conversion Factors for Agricultural Products, Ottawa, July 1954.

Multiple Regression analysis was chosen as the operational technique on which the data were analysed. The basic form of the model was of the Cobb-Douglas type which may be expressed algebraically as:

$$Q_{it} = \alpha X_{it}^{\beta_1} X_{2t}^{\beta_2} X_{3t}^{\beta_3} \cdots e_t^{\beta_n X_{nt}} \varepsilon$$

where Q_{it} denotes per capita consumption of the i^{th} commodity at time t, X_{it} = real price of the i^{th} commodity at time t, X_{2t} = real disposable income per capita at time t, $X_{3t} \cdots X_{n-1t}$ = real prices of related commodities at time t, e denotes a constant the natural logerithm of which is 1, X_n = the change-in-taste variable and ε, represents the population error. The alpha (α) coefficient represents the numeric constant expected in absence of disturbances from the causal variables while the beta (β) coefficients represent the individual regression coefficients to the respective independent variables ($X_1 \cdots X_n$). On the assumption that the α and β parameters may be estimated by sample statistics, the basic form of the model as applied to the sample analysed was:

$$\hat{Q}_{it} = aX_{it}^{b_1} X_{2t}^{b_2} X_{3t}^{b_3} \cdots e^{b_n X_{nt}}$$

In logarithmic form this appeared as

$$\log \hat{Q}_{it} = \log a + b_1 \log X_{it} + b_2 \log X_{2t} + b_3 \log X_{3t} + \cdots + b_n X_n .$$

The first difference form of the basic model was used since, from preliminary tests conducted, it appeared that this modification was the most effective in reducing autocorrelation and multicollinearity, the disturbances which are usually present in time series data. The first difference form of the model and that which was used throughout the analysis was:

$$\Delta \log \hat{Q}_{it} = \log a + b_1 \Delta \log X_1 + b_2 \Delta \log X_2 + b_3 \Delta \log X_3 + \cdots + b_n X_n .$$

The demand functions derived are those upon which statistical predictions for 1970 were based. These are summarized in Appendix C (Table XX), with standard errors of each regression coefficient given in parentheses. Statistical predictions of consumption of selected foods in 1970 are also presented in Appendix C (TableXXI). From these results the following observations may be made:

a. In about 80 per cent of the cases analysed price elasticity estimates were negative and statistically significant. This suggests that a one per cent increase in the prices of these commodities is likely to bring about significant reductions in the quantities consumed, at varying degrees of responsiveness. From the significance of these price quantity relationships the first hypothesis may be accepted on basis of the empirical evidence.

b. Margarine and white potatoes exhibit positive and significant price quantity relationships. The demand for each is highly inelastic (about .2). These factors, together with a negative and large income elasticity for margarine, aid in identifying this commodity as a Giffen good. The situation with potatoes is less clear; quantity consumed of this commodity appears to increase as price and disposable income increase.

c. The commodities for which demand is highly inelastic are: dairy products (as a composite), butter, margarine, coffee, tea, sugar, white potatoes and wheat flour. In all the cases, with the exception of margarine and white potatoes, price reductions will result in drastically reduced revenues and will promote imperceptible increases in the quantities consumed.

d. Demand for lamb and poultry meat (the composite) is highly

elastic. This indicates that price decreases or increased output of these products will enhance revenues, providing production costs remain stable.

e. Disposable income exerts a significant influence on food consumption. Significant income consumption relationships were discovered in 70 per cent of the cases analysed. On basis of this observation the second hypothesis may also be accepted.

f. In view of the negative and significant income elasticities the following commodities appear to be economically inferior: pork, margarine, lard, wheat flour and cereal products. There are indications that lamb and shortening may also be inferior goods but the tendency has not been empirically substantiated.

g. The significant cross relationships between individual commodities and groups of commodities offer empirical proof that consumption of some commodities will increase or decrease when the prices of others change. That is, some foods are substitutable while others are complementary. On basis of this observation the third hypothesis has been accepted.

h. Substitutability and complementarity between some foods have not been clearly established. Although there are apparent indications toward one or the other alternative, the lack of statistical significance in addition to the comparatively high standard errors renders a specific pronouncement of these cross relationships impossible.

i. The highest percentage increase in total consumption in 1970 (over 1962) is anticipated for cheese, margarine, coffee, poultry products and the red meats. On the other hand, total consumption is expected to decrease in the case of butter and tea.

j. The United States continues to be the major competing supplier to Canada. This is possible because of the high levels of technological progress that result in large economies in production, processing and marketing of foods, and consequently lower supply prices. Geographic proximity with relatively easy movement of goods between them has made Canada's position more vulnerable.

k. In view of the competition faced from the United States, Canada might be benefitted by expansion in certain of the agricultural enterprises for which the future economic potential is great. Some examples of note are the red meats, poultry products, margarine and cheese. In this respect there is the need for planning and training with a view to developing the necessary skills, technology, and hence comparable economies, in all aspects from production to consumption. Government assistance through long term loans and modified trade policies, including accelerated search for more stable supplies of foods not produced domestically, might also be necessary means of lessening complaint and discontent among producers and consumers. Producers might then be able to exploit more fully the economic potentials available, thereby enhancing financial returns to farming. Consumers might be in a better position to procure their food requirements at prices deemed more satisfactory than at present.

l. It is indicated that less emphasis ought to be given to certain commodities now produced. Some examples of note are fluid whole milk, lard and shortening. As an alternative, attention should be directed to expanding or initiating the potentially lucrative enterprises such as may be expected in the red meats and poultry industries.

Recommendations for Future Research

The main objective in the present investigation was to derive a set of price, income and cross elasticities estimates which could be utilized as bases for agricultural planning, forecasting and decision-making in Canada. The results presented indicate that this objective has only been partially satisfied, in spite of the observation that all the hypotheses formulated have been accepted.

There are apparent weaknesses, particularly with regard to the magnitude, direction, and significance of many of the elasticities derived. The size of the standard errors of many of these parameters was large enough to conceal clear and specific economic relationships in a number of instances where there was no statistical significance attached. This was particularly true with beverages (coffee and tea) and vegetables.

An examination of the estimates of multiple coefficients of determination (R^2) and standard error of estimate (S) revealed that a better "fit" of the lines of regression to the data may be desirable. In other words, it appears that the operational technique employed resulted in a high proportion of unexplained variability in consumption of some foods. Such was the case with pork, eggs, fluid whole milk, cheese, coffee, tea and vegetables.

On basis of the above weaknesses it is suggested that:

1. As a means of verifying, refuting or improving the estimates derived in this study future investigators might examine the feasibility of employing a different treatment from that of the present study. Consideration might be given to the application of family budgeting, ordering or scaling preference methods.

2. Since there are valid reasons for doubting the reliability of the data published, it might be necessary to have these data revised at the source prior to analysis. There are tremendous difficulties attached to this suggestion but nevertheless the possibility is not too remote.

3. The time element deserves adequate consideration as well. There should be ample time available before future studies are undertaken. This will enable the investigators to engage in pretesting several, different and logical variable-combinations with a view to arriving at the most satisfactory. In other words it provides the opportunity whereby the most relevant variables may be selected for analysis.

There is a possibility that current importation of foods like poultry meats and eggs into Canada might impose severe economic difficulties on isolated individual farm units since these imports might be concentrated in isolated areas, particularly those closer to the foreign supply centres. It is therefore suggested that separate studies be conducted at the micro level and aimed primarily at discovering the true implications to these farming units and their possible consequence to the economy at large. Information thus gained is expected to be helpful in gearing the pace and depth with which remedial steps might be introduced by farmers, business and governments.

In light of predicted consumption it is further suggested that studies be undertaken to evaluate and determine Canada's potential for expansion of her major and most promising agricultural enterprises. These studies may be expected to form reliable bases upon which to gradually proceed with expansion geared to requirements as they arise.

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A P P E N D I X

APPENDIX A

TABLE XIX

AVERAGE PROPORTIONATE ALLOCATION OF PERSONAL EXPENDITURE ON GOODS AND SERVICES, CONSTANT (1949) DOLLARS, CANADA, 1926-62*

Items	Average Annual Personal Expenditure				
	1926-39	1947-51	1952-56	1957-61	1962
	----------Per cent ----------				
Food	29.6	27.1	26.0	25.8	24.8
Tobacco and Alcoholic Beverages	5.5	7.7	7.5	7.9	7.7
Clothing and personal furnishings	12.8	13.8	12.2	11.7	11.4
Shelter	11.7	10.8	11.0	11.8	12.2
Household operation	14.1	13.0	13.2	13.7	13.8
Transportation	8.2	9.8	11.7	12.2	12.8
Personal and medical care and death expenses	5.7	6.3	6.0	6.6	7.2
Miscellaneous	12.4	11.5	12.4	10.3	10.1

*Sources: Calculated from National Accounts, Income and Expenditure, 1926-56; 1962. The years of World War II (1940-46) are omitted.

APPENDIX B

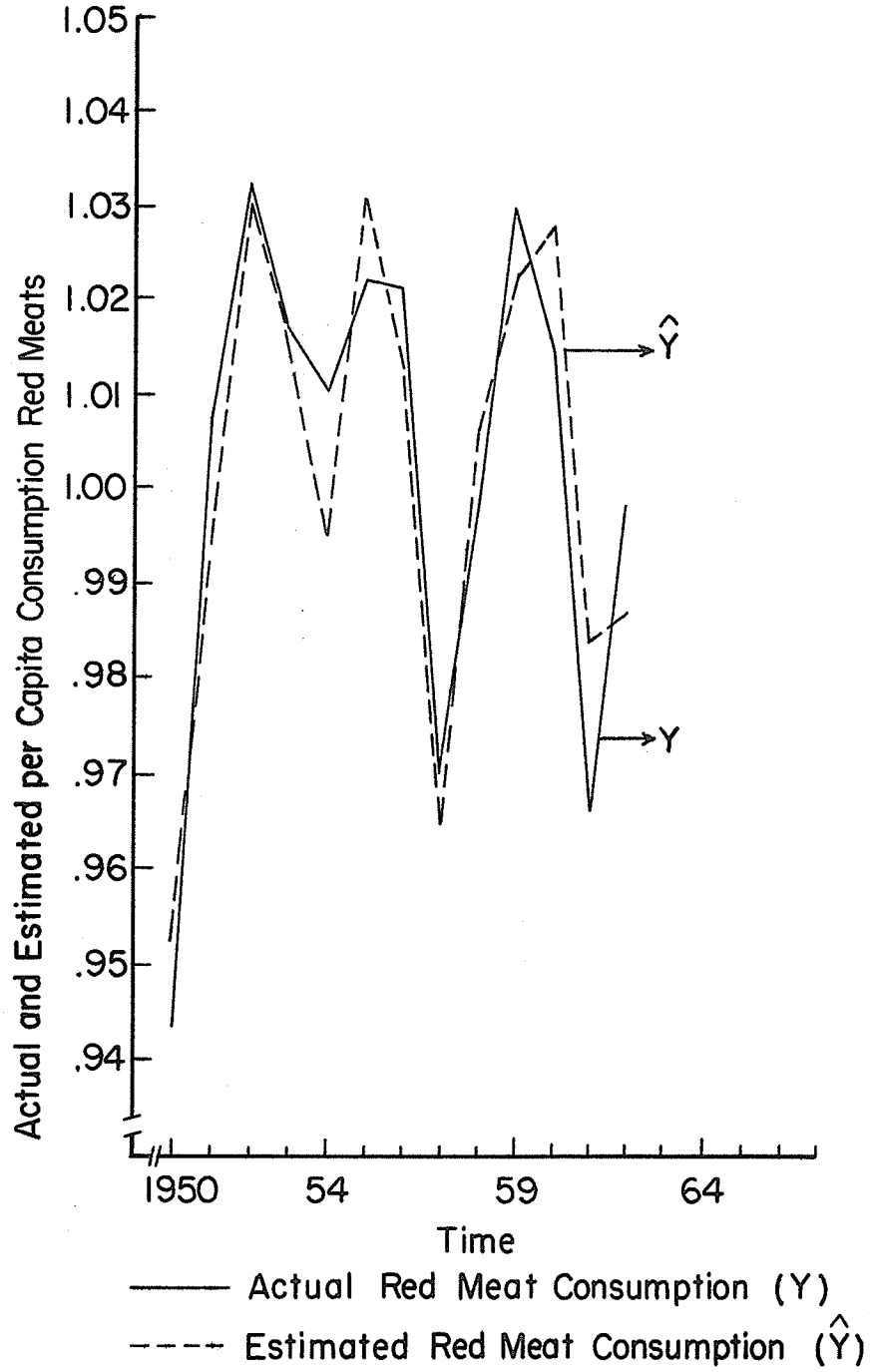

Fig. VII

APPENDIX B (continued)

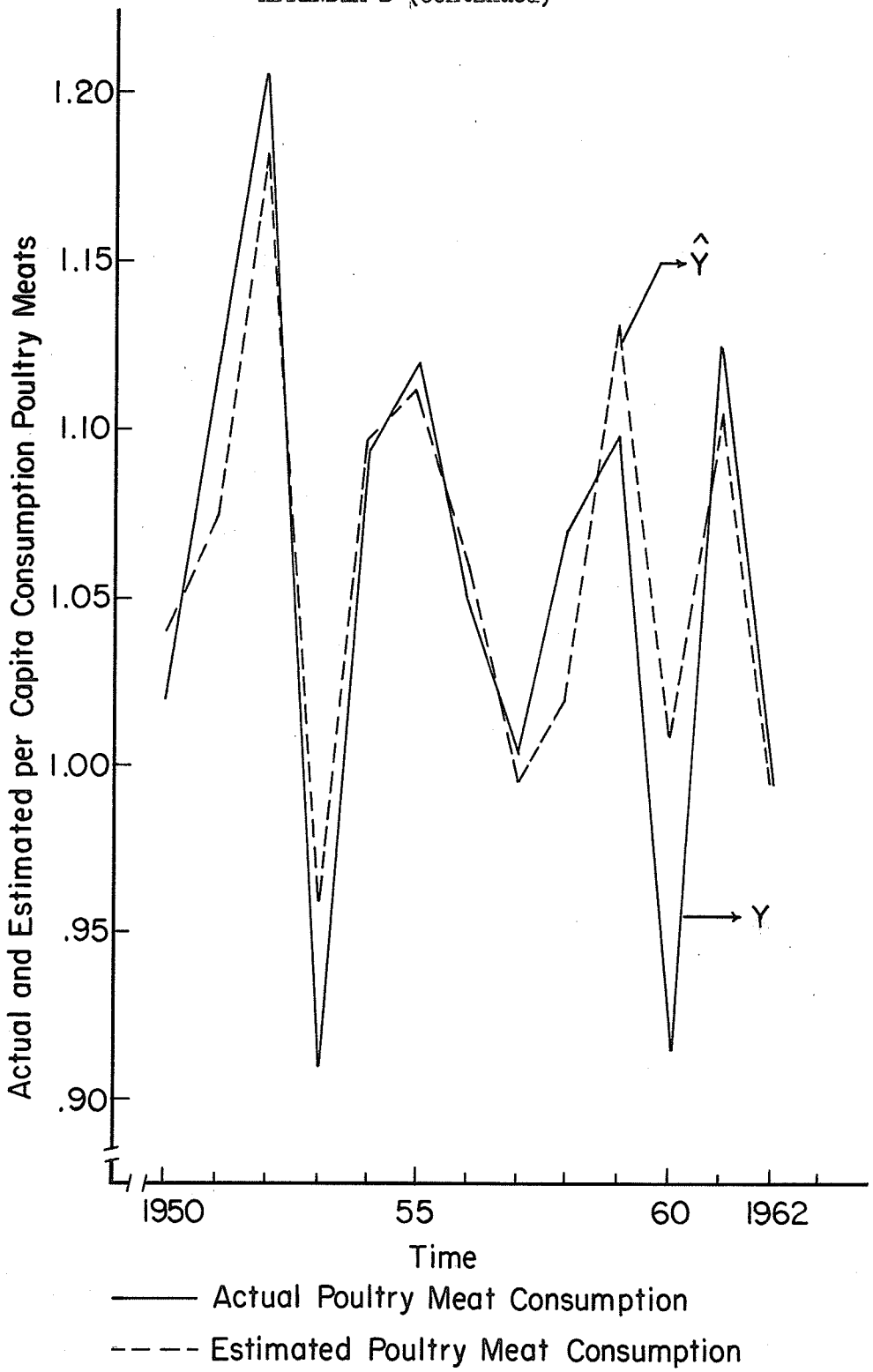

Fig. VIII

APPENDIX B (continued)

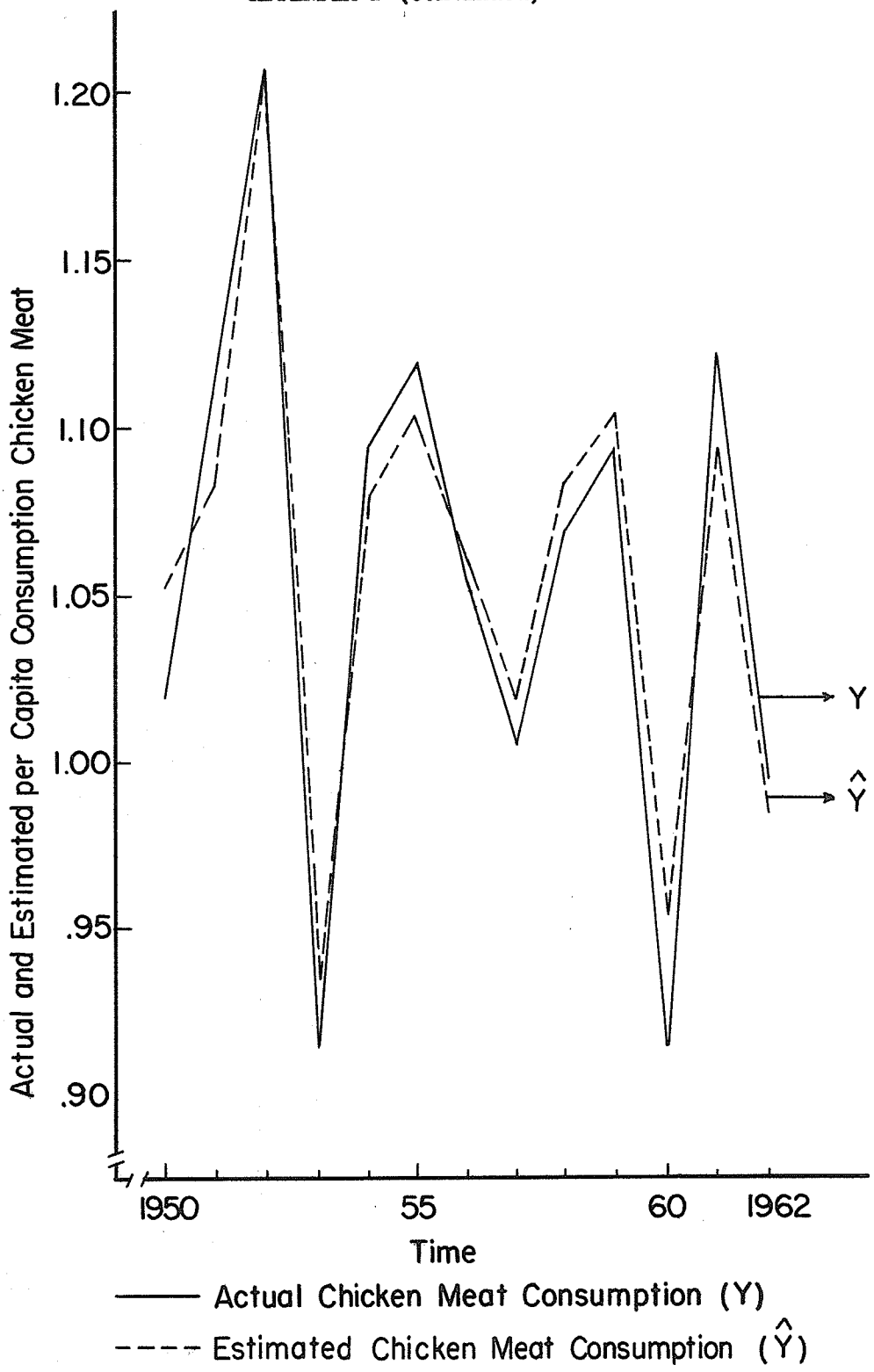

Fig IX

APPENDIX B (continued)

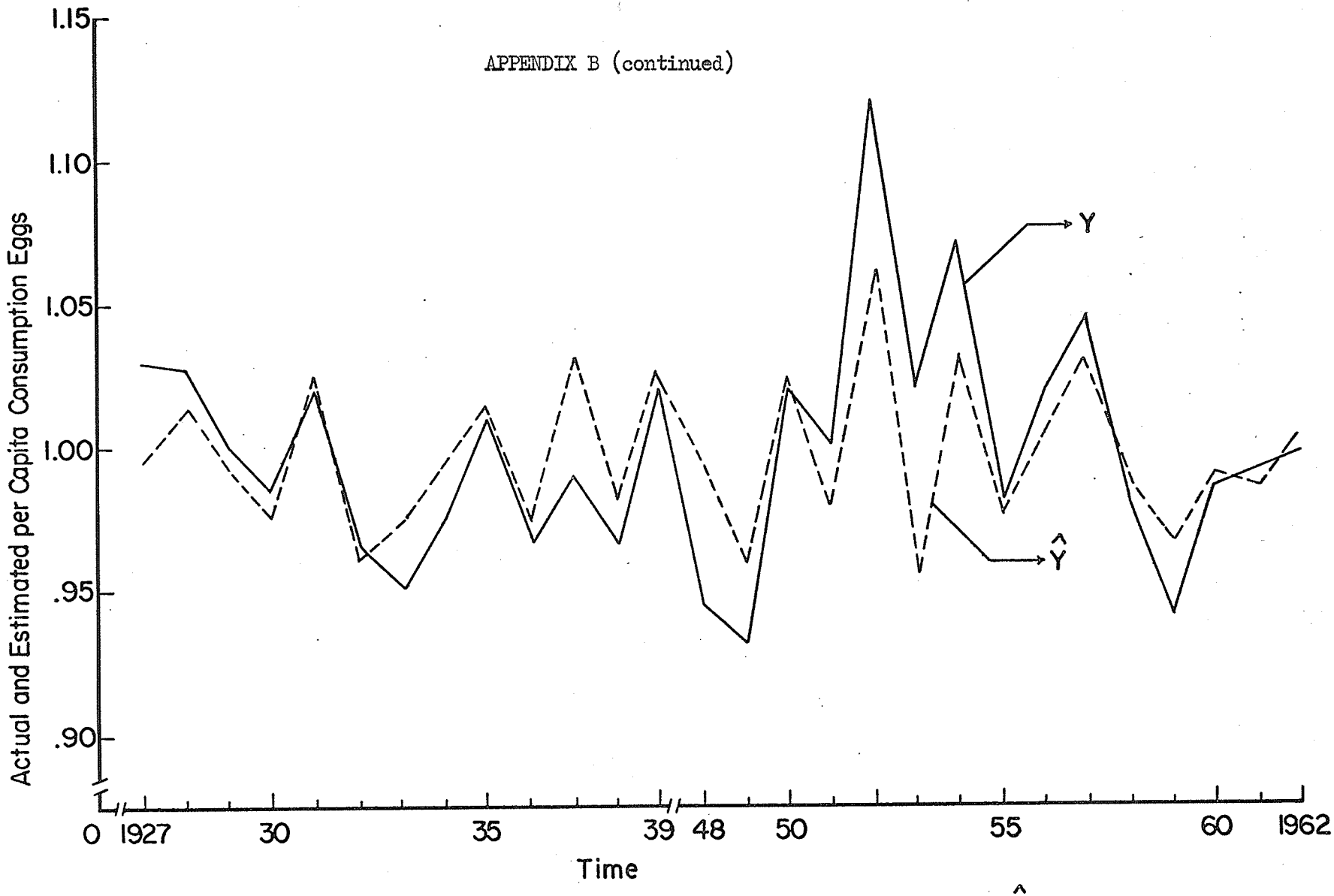

Fig. X

APPENDIX B (continued)

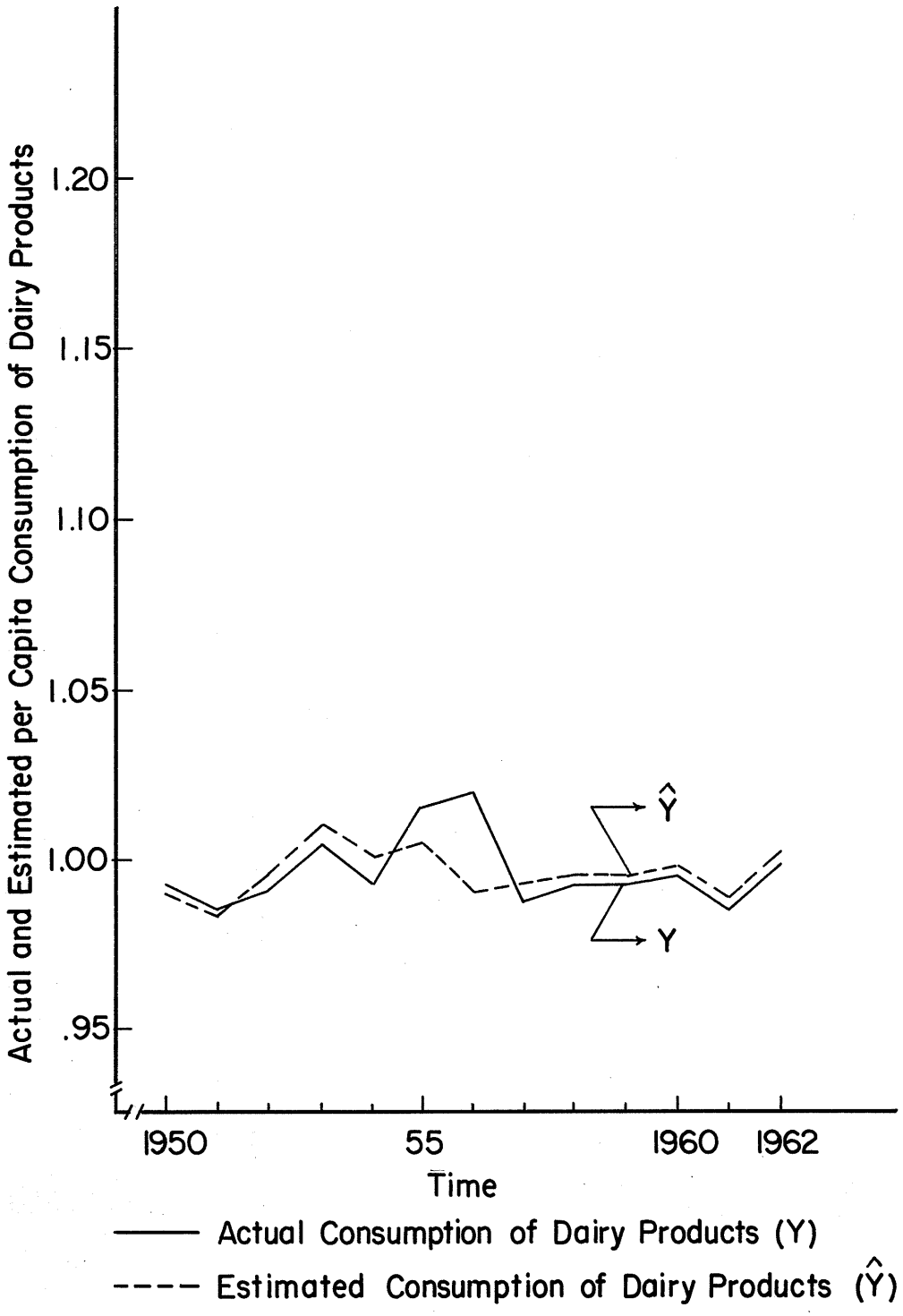

Fig. XI

TABLE XX

DEMAND FUNCTIONS FOR SELECTED AGRICULTURAL COMMODITIES, AND COMMODITY GROUPS, CANADA, 1926 - 62[a]

Commodity		Constant	Price Elasticity	Income Elasticity	Cross Elasticities																
					Chicken Meat	Cereals	Dairy Products	Beverages[b]	Vegetables	White Potatoes	Pork	Lamb	Beef	Red Meats[c]	Bread	Margarine	Eggs	Butter	Lard	Shortening	Wheat Flour
Red Meats	(Y_1)	.99	-.43^{+} (.17)	.35^{+} (.33)	-.07 (.14)	-.23$^{\#}$ (.16)	-.42^{++} (.42)	-.09^{++} (.10)	.07 (.12)	.02 (.03)											
Beef	(Y_2)	1.00	-.31 (.51)	.19 (.24)	.13 (.65)						.36$^{\#}$ (.26)	-1.20* (.45)									
Pork	(Y_3)	1.04	-.66* (.29)	-1.43^{++} (1.54)	.25 (.67)							.16 (.55)	.08 (.50)								
Lamb	(Y_4)	1.04	-1.78** (.47)	-.89 (1.31)	.51^{++} (.57)						.06 (.25)		-.03 (.43)								
Poultry meats[d]	(Y_5)	.98	-1.06** (.30)	1.12$^{\#}$ (.81)										-.64$^{\#}$ (.45)							
Chicken meat	(Y_6)	.99	-.78* (.32)	1.13^{++} (.65)		-.55* (.36)			-.37^{++} (.28)	.03 (.07)				-.14 (.42)							
Eggs	(Y_7)	1.00	-.31** (.08)	.37* (.16)		-.01 (.05)															
Dairy Products[e]	(Y_8)	.98	-.01 (.19)	.31* (.14)			.02 (.05)							-.08^{++} (.07)	.36$^{\#}$ (.29)						
Fluid whole milk and cream	(Y_9)	.99	-.47^{++} (.40)	.14 (.16)			-.02 (.10)							-.13^{++} (.13)	.30$^{\#}$ (.20)						
Butter	(Y_{10})	.94	-.15^{++} (.17)	.86^{+} (.43)											-.93^{++} (.92)	.09 (.17)	.09 (.10)				
Cheese	(Y_{11})	.99	-.71^{++} (.81)	.71^{++} (.61)											1.73$^{\#}$ (1.32)						

[a]Levels of significance used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent

[b]Inclues coffee and tea.

[c]Includes beef and veal, pork and lamb.

[d]Indicates turkey and chicken meat.

[e]Includes whole milk, butter, cheese.

[f]Includes white potatoes and wheat flour.

TABLE XX

DEMAND FUNCTIONS FOR SELECTED AGRICULTURAL COMMODITIES, AND COMMODITY GROUPS, CANADA, 1926 - 62[a]

Cross Elasticities

Chicken Meat	Cereals	Dairy Products	Beverages[b]	Vegetables	White Potatoes	Pork	Lamb	Beef	Red Meats[c]	Bread	Margarine	Eggs	Butter	Lard	Shortening	Wheat Flour	Coffee	Tea	Sugar	Starches[f]	Change in Consumers' Preferences	R^2	S
.07 .14)	- .23# (.16)	- .42++ (.42)	- .09++ (.10)	.07 (.12)	.02 (.03)																	.846#	.008
.13 .65)						.36# (.26)	-1.20* (.45)															.854*	.026
.25 .67)							.16 (.55)	.08 (.50)														.522	.035
.51++ .57)						.06 (.25)		-.03 (.43)														.781*	.030
									- .64# (.45)													.579*	.026
	- .55* (.36)			- .37++ (.28)	.03 (.07)				- .14 (.42)													.841*	.020
	- .01 (.05)																				Increase	.406*	.015
			.02 (.05)						- .08++ (.07)	.36# (.29)												.527	.004
			- .02 (.10)						- .13++ (.13)	.30# (.20)											Decrease	.303#	.014
										- .93++ (.92)	.09 (.17)	.09 (.10)										.412#	.012
										1.73# (1.32)												.206	.060

cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ = 40 per cent

[c]Includes beef and veal, pork and lamb. [d]Indicates turkey and chicken meat.

[f]Includes white potatoes and wheat flour.

TABLE XX (CONTINUED)

DEMAND FUNCTIONS FOR SELECTED AGRICULTURAL COMMODITIES, AND COMMODITY GROUPS, CANADA, 1926 - 62[a]

Commodity		Constant	Price Elasticity	Income Elasticity	Chicken Meat	Cereals	Dairy Products	Beverages[b]	Vegetables	White Potatoes	Pork	Lamb	Beef	Red Meats[c]	Bread	Margarine	Eggs	Butter	Lard	Shortening	Wheat Flour	[illegible]
					Cross Elasticities																	
Margarine	(Y_{12})	1.12	$.25^{++}$ (.23)	$-1.09^{\#}$ (.70)											-1.02^{*} (.52)			$.26^{++}$ (.29)				
Lard	(Y_{13})	1.05	$.94^{**}$ (.23)	-1.85^{*} (1.03)												$.73^{\#}$ (.56)				1.37^{*} (.57)		
Shortening	(Y_{14})	1.00	$-.56^{+}$ (.33)	- .49 (.34)												$.35^{++}$ (.36)			$.20^{+}$ (.11)			
Coffee	(Y_{15})	1.08	$-.28^{++}$ (.26)	.23 (.25)																		
Tea	(Y_{16})	1.00	-.26 (.50)	- .35 (.42)																		[illegible]
Sugar	(Y_{17})	1.01	$-.27^{*}$ (.09)	$.18^{++}$ (.18)																		[illegible]
White potatoes	(Y_{18})	.93	$.21^{++}$ (.19)	.42 (.35)					-.79 (1.01)					.57 (.20)							$.51^{+}$ (.31)	
Wheat flour	(Y_{19})	1.03	-.24 (.43)	-1.67^{+} (.75)					$.55^{+}$ (.11)	$.06^{++}$ (.06)				.19 (.41)								
Cereals	(Y_{20})	1.03	$-.56^{*}$ (.20)	-2.33^{**} (.37)			-2.48^{**} (.47)		$.32^{+}$ (.15)	$.10^{*}$				.13 (.19)								
Vegetables	(Y_{21})	1.04	-.46 (.35)	1.69^{++} (1.93)										-.15 (.07)								

[a]Levels of significance used: ** = 1 per cent; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ - 40 per cent

[b]Includes coffee and tea.

[c]Includes beef and veal, pork and lamb.

[d]Indicates turkey and chicken meat.

[e]Includes whole milk, butter, cheese

[f]Includes white potatoes and wheat flour.

TABLE XX (CONTINUED)

DEMAND FUNCTIONS FOR SELECTED AGRICULTURAL COMMODITIES, AND COMMODITY GROUPS, CANADA, 1926 - 62[a]

Chicken Meat	Cereals	Dairy Products	Beverages[b]	Vegetables	White Potatoes	Pork	Lamb	Beef	Red Meats[c]	Bread	Margarine	Eggs	Butter	Lard	Shortening	Wheat Flour	Coffee	Tea	Sugar	Starches[f]	Change in Consumers' Preferences	R^2	S
										−1.02* (.52)			.26++ (.29)									.601*	.021
											.73# (.56)				1.37* (.57)							.733*	.035
											.35++ (.36)			.20+ (.11)								.469#	.022
																		.28 (.39)	−.19 (.26)		Increase	.114	.057
																	.21 (.34)		−.14 (.35)		Decrease	.060	.074
																	.05 (.09)	.18# (.13)			Increase	.415*	.019
				−.79 (1.01)					.57 (.20)							.51+ (.31)						.545#	.071
				.55+ (.11)	.06++ (.06)				.19 (.41)													.533#	.024
		−2.48** (.47)		.32+ (.15)	.10*				.13 (.19)													.917*	.010
									−.15 (.07)											−.12 (.36)		.104	.061

nt; * = 5 per cent; + = 10 per cent; # = 20 per cent; ++ - 40 per cent

[c]Includes beef and veal, pork and lamb.

[d]Indicates turkey and chicken meat.

[f]Includes white potatoes and wheat flour.

APPENDIX C (continued)

TABLE XXI

PREDICTED CONSUMPTION OF SELECTED FOODS AND FOOD GROUPS, CANADA, 1962-1970*

Commodity	Per Capita Consumption		Change in Total Consumption
	1962	Predicted for 1970	1962 - 70
			Per cent
Red Meats	138.5	165.7	41.7
Beef	76.4	85.0	36.0
Pork	49.9	56.9	35.0
Lamb	3.8	4.7	46.5
Poultry Meat	32.6	42.0	55.0
Chicken Meat	31.0	41.0	57.4
Eggs	35.6	45.9	52.7
Fluid whole milk and cream	385.3	377.1	16.0
Butter	16.4	8.8	-36.4
Cheese	8.6	16.6	128.7
Coffee	9.0	13.2	74.0
Tea	2.4	1.8	-11.2
Sugar	97.0	89.4	9.2
Margarine	10.1	18.9	121.6
Lard	7.2	6.6	8.6
Shortening	9.0	8.1	6.6
White potatoes	164.0	148.0	7.0
Wheat flour	132.6	126.2	10.0
Cereals	139.3	131.1	11.7

*Source: Computed.