AN ECONOMIC ANALYSIS OF FACTORS INFLUENCING DEMAND AND PRICES IN THE CANADIAN POULTRY MEAT INDUSTRY

A Thesis
Presented to
The Faculty of Graduate Studies and Research
University of Manitoba

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
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February 1973

ACKNOWLEDGMENTS

The author wishes to express his appreciation to those persons to whom he is indebted in the preparation of this thesis.

The author acknowledges the guidance of Dr. R. M. A. Loyns, under whose direction the thesis was written.

The author acknowledges the selflessness of his wife whose understanding and encouragement made the project tolerable and, at times, possible.

The author acknowledges the funds received from the Manitoba Marketing Board at the outset of the project, and from the Canadian Turkey Federation and Canadian Broiler Council throughout the project.

ABSTRACT

AN ECONOMIC ANALYSIS OF FACTORS INFLUENCING DEMAND AND PRICES IN THE CANADIAN POULTRY MEAT INDUSTRY

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1973

In recent years considerable growth in consumption of poultry meats has occurred in Canada. During the same period, the historical roles of price and individual decision-making in the poultry meat industry have been supplanted by increasingly greater degrees of centralized decision-making and administration of prices. A basic need exists for understanding economic forces which influence, or operate within the poultry sector of the meats economy. The study to follow was designed to satisfy three objectives:

1. To discuss and provide quantitative measures of the determinants of demand;

2. To assess the relationship between prices at each market level by an examination of the structure of marketing margins;

3. To provide a model which may be used for making short-term forecasts of poultry prices.

The study period was composed of the months covering

1963-1970. The mathematical tool employed to discover fundamental relationships was multiple regression analysis. Three economic models were specified to explain:

1. Income-consumption relationships;
2. Retail price relationships;
3. Wholesale-farm market relationships;

for five subclasses of poultry meat where data permitted. Since a simultaneous solution was required for the farm-wholesale model, two-stage least squares regression techniques were applied to obtain estimates of structural parameters. Finally these models were applied in making short-term price forecasts.

The results of empirical analysis of the models were in general accord with those from the literature reviewed. For the five poultry meat subclasses, price elasticities of demand were obtained, or derived, for each market level. These results were highly elastic. Revealed in most of the structural equations was an undesirably high degree of serial correlation. This suggests the possibility of a missing variable(s) which could be interpreted to be the effect on the poultry markets brought about by administered pricing policies of provincial marketing boards. The evaluation of this hypothesis has been left for further study.

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CHAPTER I

INTRODUCTION

A. MAJOR DEVELOPMENTS IN THE POULTRY MEAT INDUSTRY

The production of poultry meat in Canada represents an important contribution to farm income. During the past two decades, the proportion of farm income earned from poultry enterprises has increased from 3.53% in 1950 to 6.30% in 1970 as shown by the data in Table I.

TABLE I

CASH INCOME FROM SALE OF FARM PRODUCTS IN CANADA
(excluding Newfoundland)

	1950	1960	1970
		('000 dollars)	
Poultry meat	74,966	134,450	258,859
Total income	2,122,000	2,734,500	4,108,600

Source: Statistics Canada, Quarterly Bulletin of Agricultural Statistics, 21-003, Ottawa, 1951, 1961, 1971.

The same period has been characterized by generally declining producer price levels for all classes of poultry meat.

Consumption of poultry meats in Canada for the

period 1950 to 1970 has shown an upward trend. Table II shows that per capita consumption of fowl and chicken was 18.3 pounds, and of turkey was 3.1 pounds in 1950; in 1970 per capita consumption had risen to 34.3 pounds and 10.0 pounds respectively. As well, the distribution of poultry meat consumption has changed. As a percentage of total poultry meat consumption, the amount of fowl and chicken consumed has decreased from 83.4% in 1950 to 76.5% in 1970 while turkey consumption increased from 13.9% to 22.4% and goose and duck meat declined from 2.8% to 1.1%.

Within the chicken and turkey classes of poultry meat, significant changes have occurred in the techniques of production and marketing. Improvements in genetic structure have resulted in strains of birds that are noted for their feeding efficiency and disease resistance, thus improving their potential for meat production. According to Emmery (5:1967:6), in the early nineteen-fifties the major proportion of chicken and fowl meat was made up of the heavy or roasting chicken class produced largely as a by-product of the egg industry. In recent years the emphasis has changed so that the major proportion of chicken produced is of the lighter weight birds. As a percentage of total fowl and chicken produced, heavy weights have decreased from 70.4% in 1953 to 15.2% in 1970. For turkey meat, the proportion of heavy weight turkey has shown a similar, though smaller, decline from 84.3% in 1958 to 63.4% in 1970. In Figures I to V the monthly average sizes

TABLE II

CONSUMPTION OF POULTRY MEAT IN CANADA

Category	1950 Per Capita	1950 Total	1960 Per Capita	1960 Total	1970 Per Capita	1970 Total
	(dressed weight)		(eviscerated wt.)		(eviscerated wt.)[a]	
	lbs.	'000 lbs.	lbs.	'000 lbs.	lbs.	'000 lbs.
Fowl and Chicken	18.3	245,135	20.8	372,077	34.3	733,670
Turkey	3.1	41,049	6.4	113,548	10.0	214,707
Goose	0.3	4.633	0.2	2,794	0.2	3,503
Duck	0.3	3,468	0.3	5,773	0.3	6,570
Total	22.0	294,285	27.7	494,192	44.8	958,450

Source: Canada Department of Agriculture, Poultry Division and Market Information Section, Production and Market Branch, Poultry Market Review, (Annual), Ottawa, 1952-1970.

[a] A summary of definitions begins on page 19.

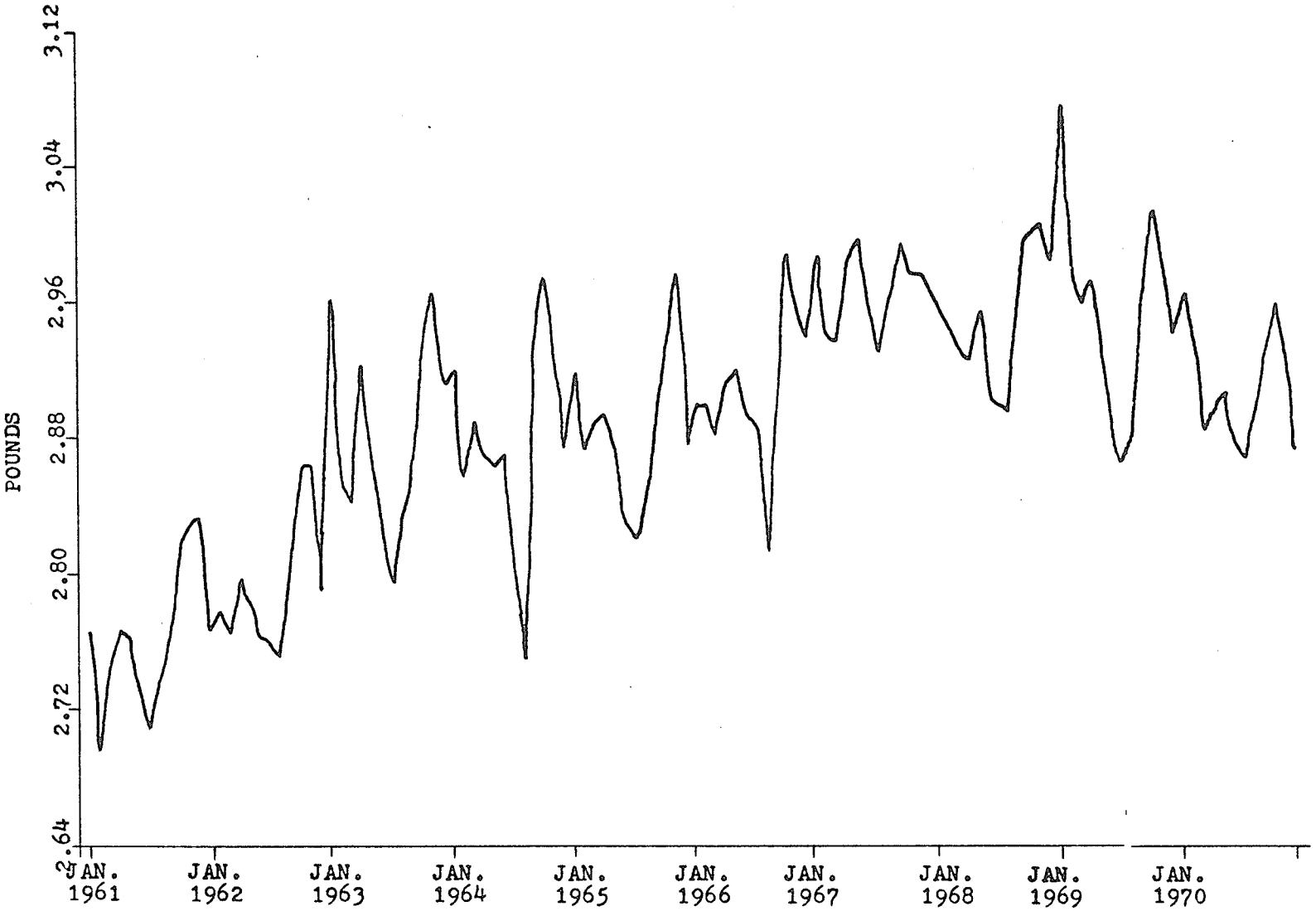

FIGURE I

AVERAGE EVISCERATED WEIGHT OF BROILER CHICKENS
(1961-1970)

FIGURE II

AVERAGE EVISCERATED WEIGHT OF HEAVY CHICKENS
(1961-1970)

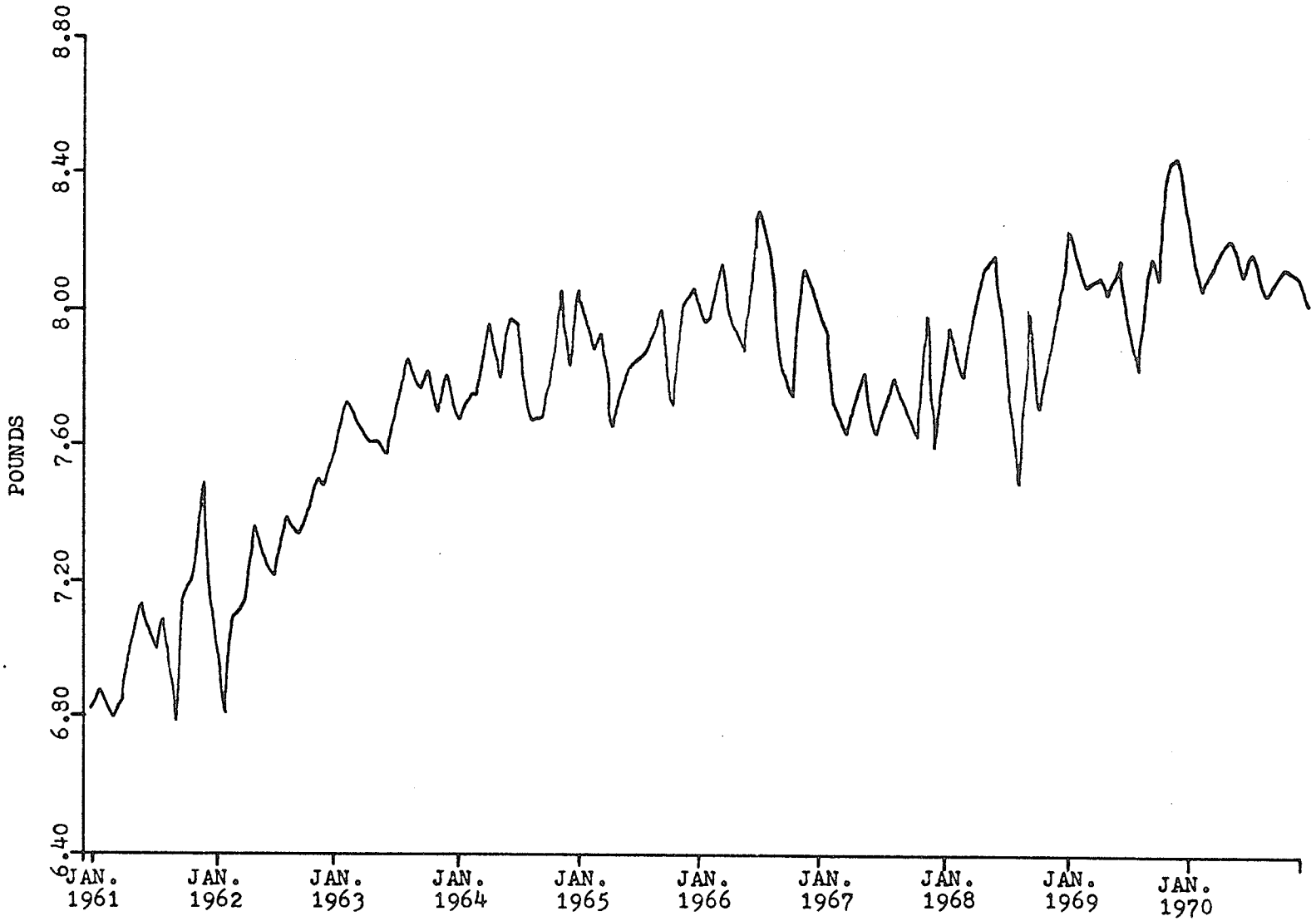

FIGURE III

AVERAGE EVISCERATED WEIGHT OF BROILER TURKEYS
(1961-1970)

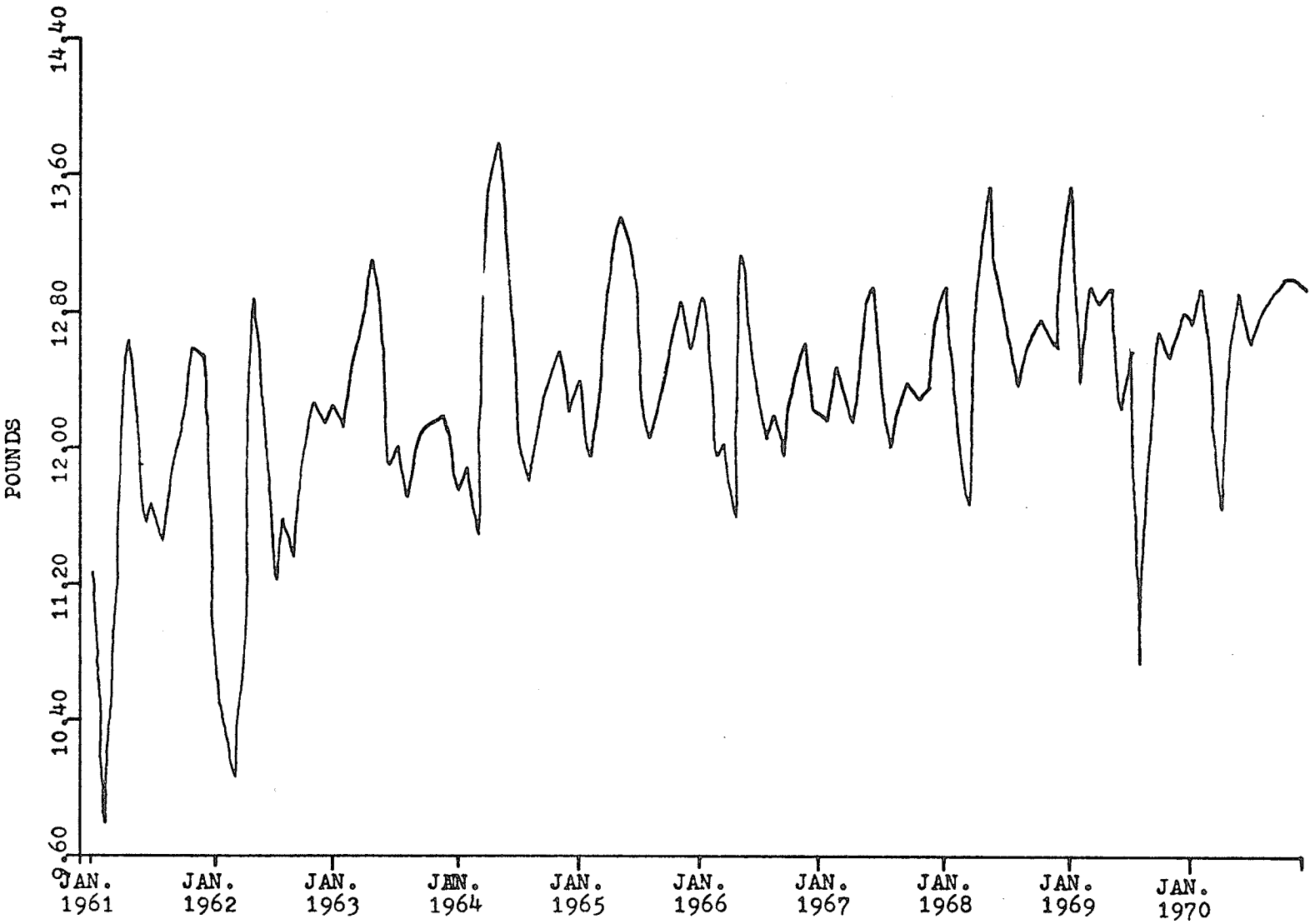

FIGURE IV

AVERAGE EVISCERATED WEIGHT OF HEN TURKEYS
(1961-1970)

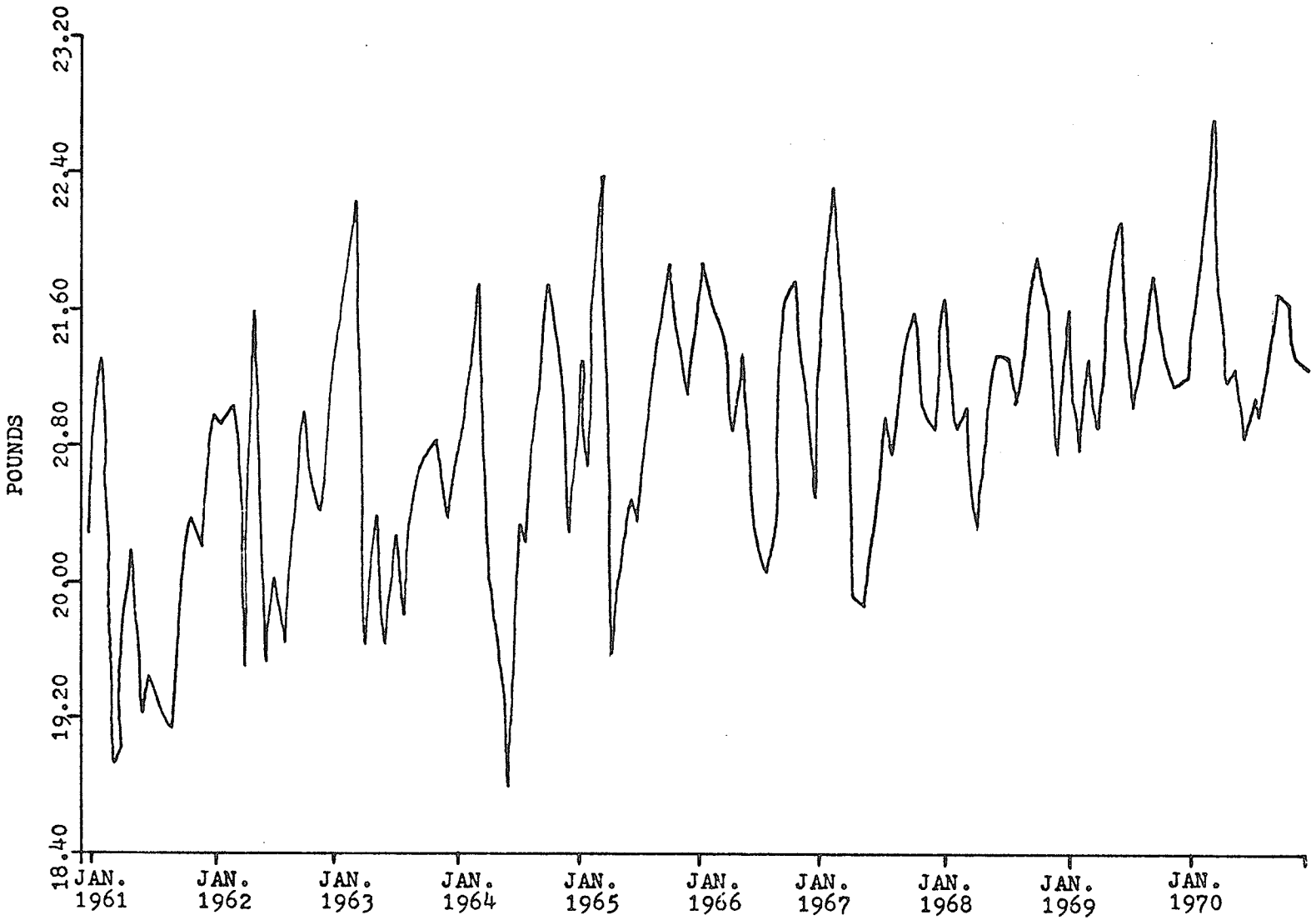

FIGURE V

AVERAGE EVISCERATED WEIGHT OF TOM TURKEYS
(1961-1970)

of five categories of poultry meat slaughtered in registered stations in Canada are shown for the period 1961 to 1970.

Such changes in production can be viewed as adaptations to changing consumer preferences. The growing market demands for smaller birds are in part a response by homemakers to newly advanced marketing techniques. According to Hill (14:1966:11-12), broiler chickens and broiler turkeys have become more readily available through retail outlets, have been presented in ready-to-cook fresh or frozen form, and have been subjected to a greater degree of sales presentation in recent years. The overall meats economy, of which the poultry industry is a related part, has experienced similar growth of consumer demand in recent years and the poultry meat sector is expected to compete with beef and pork for the consumer's dollar.

Canadian trade with other countries in poultry meats has been very small in relation to production. Canada has maintained the position of a net importer of poultry meat products since 1953. Between 1952 and 1970, average annual imports of chicken were equal to 0.83% of domestic production, and average annual turkey imports amounted to 4.68% of production (Table III). The data in TableIII also show that for the same period, exports as a percentage of production averaged 0.06% for chicken and 0.12% for turkey. It is important to note that the Canadian producer is protected from United States imports

TABLE III

EXPORTS, IMPORTS, AND TOTAL DOMESTIC PRODUCTION OF CHICKEN AND TURKEY 1952-70

	Exports		Imports		Total Production	
Year	Chicken	Turkey	Chicken	Turkey	Chicken	Turkey
			('000 lbs.)			
1952	366	16	25	358	37,437	29,121
1953	130	16	445	5,275	51,956	24,077
1954	188	51	111	5,258	69,146	40,953
1955	77	14	514	10,394	72,494	54,716
1956	67	11	1,330	12,432	114,810	91,884
1957	109	8	1,513	6,354	130,187	118,786
1958	178	4	6,102	452	177,881	153,662
1959	30	69	3,253	343	191,097	195,399
1960	4	7	5,694	4,149	211,074	168,061
1961	48	7	3,247	4,041	270,273	118,905
1962	485	19	1,955	2,452	272,176	128,108
1963	8	289	1,109	39	317,836	123,050
1964	48	134	620	5,373	348,008	140,373
1965	1	800	1,627	155	376,005	163,230
1966	-	1,062	1,116	-	423,442	187,809
1967	3	65	845	1,323	457,712	193,374
1968	-	106	1,000	351	482,730	192,536
1969	-	306	1,337	-	560,135	194,610
1970	86	661	750	-	609,872	203,692

Source: Canada Department of Agriculture, Poultry Division and Market Information Section, Production and Market Branch, Poultry Market Review, (Annual), Ottawa, 1952-1970.

by a 12.5% ad valorem tariff on dressed and eviscerated poultry, with the restriction that the import duty be not less than five cents per pound nor more than ten cents per pound. The tariff on live poultry moving from United States to Canada is two cents per pound. This import protection has generally enabled Canadian producers to attain farm prices for their poultry products which exceeded corresponding prices received by their American counterparts.

Inventory holdings of poultry meats are predominantly related to seasonal or short-term factors. For many Canadians the consumption of poultry meat, especially turkey, is still reserved for festive occasions such as Thanksgiving and Christmas. Hill (14:1966:11) notes that broiler chickens are primarily sold in fresh form, but broiler and heavy turkeys are generally marketed in frozen forms.[1/] The end-of-year stocks of chicken and turkey meat data presented in Table IV, show that stocks of chicken meat and of turkey meat averaged 8.45% and 17.54% of domestic production for the period 1951 to 1970.

Since 1961 the marketing of poultry meat products in Canada has gradually come under the control of provincial producer marketing boards; as of January, 1972, only Prince Edward Island and Newfoundland did not have broiler chicken

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[1/] Since Hill reported his research, there has been increased sales of frozen broiler chicken.

TABLE IV

STORAGE STOCKS AS AT DECEMBER 31 AND STOCKS AS A PERCENTAGE OF TOTAL PRODUCTION OF CHICKEN AND TURKEY 1951-1970

Year	Chicken ('000 lbs.)	Percentage of Production	Turkey ('000 lbs.)	Percentage of Production
1951	15,598	40.7	6,504	29.1
1952	7,453	19.9	8,700	29.9
1953	12,922	24.9	7,448	30.9
1954	8,009	11.6	9,632	23.5
1955	7,563	10.4	10,173	18.6
1956	11,727	10.2	16,655	18.1
1957	6,871	5.3	12,376	10.4
1958	13,367	7.5	18,346	11.9
1959	5,931	3.1	11,924	6.1
1960	6,658	3.2	10,640	6.3
1961	8,908	3.3	19,201	16.1
1962	4,908	1.8	36,717	28.7
1963	10,769	3.4	15,993	13.0
1964	10,048	2.9	21,540	15.3
1965	10,814	2.9	24,755	15.2
1966	18,054	4.3	30,349	16.2
1967	15,255	3.3	30,941	16.0
1968	16,045	3.3	33,972	17.6
1969	20,511	3.7	26,545	13.6
1970	20,000	3.3	29,041	14.3

Source: Canada Department of Agriculture, Poultry Division and Market Information Section, Production and Market Branch, Poultry Market Review, (Annual), Ottawa, 1952-1970.

marketing boards and none of the Maritime provinces regulated the marketing of turkeys. Relative to total Canadian production however, these provinces supply less than 5% of the broiler chickens and 2% of the turkeys marketed within the country. In 1971, a combined broiler chicken and turkey marketing board came into operation in Quebec.

The movement toward marketing board regulation of poultry meats arose in response to economic problems of product over-supply, instability of prices and depressed incomes to producers. With the inception of the marketing boards, it can be inferred that producers' bargaining power has improved relative to the power exercised by hatcheries, feed companies, processing agencies and retail firms in the industry. However, the individual provincial boards have been limited to exercising their powers within the respective provinces, while many of the firms operating in related segments of the industry have national orientations. These considerations have provoked a desire on the part of many producers and producer boards for national market regulation and after long debate the Farm Products Marketing Agencies Act received final approval from Parliament in January of 1972. This legislation provides for the formation of national marketing agencies for regulating the marketing of specified agricultural commodities.

Agricultural market regulation requires extensive

information on production, consumption and pricing to be operational and effective. The basic objectives of marketing board policy are to achieve stability in prices of commodities and to reduce income instability of producers. Stability may be attained by the boards through supply management policies effected by quota allocations. Prior to allotting producer quotas to achieve a particular price level though, an accurate assessment of future consumption at that price level is required.

Currently, individual provincial boards make estimates of consumption which become bases for planned production increases or cutbacks by the respective board. Coordination of market regulation strategies among provinces is attempted through communication between boards; but adequate coordination is not always achieved due to differing estimates of consumer demands within individual provinces. Hence the market regulation strategy followed by one board can be partially counteracted by that of a board in a neighbouring province. Furthermore, provincial marketing boards have been established for both chicken fowl and turkey fowl but only recently in Quebec has one board been organized to deal with both commodities. Analysing demands for poultry meats is an important step towards improving the operations of boards from a producer standpoint. The full benefit of using such regulatory plans can be achieved if information on demand interrelationships, price determining factors and trade patterns are known.

B. STATEMENT OF THE PROBLEM, OBJECTIVES, AND SCOPE

1. Problem

The development of the Canadian poultry industry, the economic problems of growth and adjustment encountered, and attempts at their solution, are similar in many respects to those of other Canadian agricultural industries. Current regulation of Canadian poultry meat production as undertaken by provincial marketing boards, is largely based on a subjective 'feel of the market'. Throughout late 1970 and early 1971, individual producer marketing boards attempted to prohibit sales within their borders of poultry products coming from outside. Their actions were partly in response to an exporting policy initiated in the province of Quebec, where stocks of poultry products, especially broiler chickens, had reached very high levels. To bring to an end the restriction of interprovincial flows of poultry required a ruling from the Supreme Court of Canada. Such actions, coupled with recent legislation at the national level in the form of a Farm Products Marketing Agency Act, indicate that there is an important basic need for understanding economic forces which influence, or operate within the poultry sector of the meats economy. As the historical roles of price and individual decision-making in the industry become supplanted by increasingly greater degrees of centralized decision-making, there is created both an opportunity and a need for obtaining additional

information and for improving existing information to add to the store of knowledge about poultry meats. Hence this study was directed at identifying the principal factors responsible for the determination of prices of Canadian poultry meats.

2. Objectives

Specifically, the study was designed to satisfy three objectives:

1. To discuss and provide quantitative measures of the determinants of demand, including:

i) variations in quantities consumed;

ii) demand elasticity with respect to price and income;

iii) the effects of competing products such as beef, pork, and the other poultry meats;

iv) the impact on the Canadian poultry market of conditions in the United States; and

v) factors which induce Canadian suppliers to move poultry commodities into or out of inventory holdings.

2. To assess the relationship between prices at each market level by an examination of the structure of marketing margins; and

3. To provide a model which may be used for making short-term forecasts of poultry prices, and to apply it to 1971.

3. Scope

A model of the Canadian poultry industry will be presented which combines time-series and cross-section data. Monthly time-series data were accumulated for the period 1963-1970. The analysis is limited to this period due to data limitations to be discussed later. The model purports to explain the formation of prices for each of the following five major classes of poultry meat:

1. broiler chickens;
2. roasting chickens;
3. broiler turkeys;
4. hen or medium weight turkeys; and
5. tom or heavy weight turkeys.

Further subdivisions based on these five exist either through grade differentiation or through division of the above classes by weight, but more specific analysis is prohibitied by a lack of published data.

Empirical analysis of the monthly model will be carried on in two phases. Initially, demand at the retail level will be examined. Then, in the next phase, wholesale and producer derived demands will be analysed using the information gained from the retail analysis as predetermined (in the statistical sense). In this manner the overall complexity of the analysis can be limited. Furthermore, it was not possible to obtain data for all categories of poultry meat at the retail market level.

Satisfaction of the objectives can be attained by an analysis based on the demand for Canadian poultry meats, having only minimal reference to supply conditions in the poultry industry. A simple short-period production forecasting model becomes necessary when considering short-term price forecasts. Nevertheless, no intensive analysis of the production characteristics is deemed necessary.

The importance of determining an accurate measure of the elasticity of demand with respect to income, and the problems encountered when using the slope coefficient from the income variable in a demand equation obtained from time-series data are discussed subsequently. In order to avoid these difficulties in this study a supplementary analysis of cross-section data was undertaken to obtain estimates of income elasticity of demand. The information obtained from the supplementary cross-section analysis was then imposed on the monthly time-series portion of the study.

CHAPTER II

THEORETICAL CONSIDERATIONS

The communication of knowledge in an accurate and easily understood manner in an underlying objective of every economic analysis. This communication is facilitated if the analyst ensues that the reader is exposed to a minimum of confusion regarding the use of technical terms, and if the reader is made acquainted with the current level of knowledge relating to the subject or commodity under consideration. This chapter presents the definitions of technical terms used in this study, discusses the results from similar analyses recently published by other researchers and outlines the economic theory relevant to the topic at hand.

A. DEFINITIONS

Several terms are used by members of the poultry industry which convey obscure or multiple meanings to the uninitiated observer. Many terms are to be defined in this section, the meaning of which will not become clear until subsequent sections of the study are read. It is necessary, however, to give the definitions of some of the often used terms in order to maintain coherency in

subsequent discussion.

Chicks and Poults

The terms chick and poult refer respectively to day-old members of chicken and turkey strains of fowl.

Cockerels and Pullets

The terms cockerel and pullet refer respectively to the male and female genders of chicken fowl.

Toms and Hens

The terms tom and hen refer respectively to the male and female genders of turkey fowl.

Subclasses of Poultry Meat[1/]

Within each of the chicken and turkey classes, several further categories of poultry can be distinguished on the basis of age and weight at maturity. On such a basis, five poultry meat classes are summarized in Table V. This study is concerned with each of the five classes.

Chicks of both genders enter the production process, and are marketed as either broilers or roasters. At seven to eight weeks of age the pullets may be marketed as junior broilers, for use by specialty outlets and sold in ready-to-eat form. At nine to twelve weeks of age, or

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1/ The definitions extended in this section were summarized from discussions between the author and Mr. E. Kitchen of the Manitoba Broiler Chicken and Turkey Producer Marketing Boards.

TABLE V

AGE, LIVE WEIGHT AND EVISCERATED WEIGHT AT MATURITY OF THE FIVE MAJOR CLASSES OF POULTRY MEAT BIRDS

Class	Age	Live Weight	Eviscerated Weight
	(weeks)	(. . . .pounds. . . .)	
Broiler chicken	9 to 12	under 5	under 4
Roasting chicken	13 to 16	over 5	over 4
Broiler turkey	14 to 15	under 12	under 10
Hen turkey	19 to 21	12 to less than 20	10 to less than 16
Tom turkey	21 to 25	over 20	over 16

Source: Adapted from L. B. Siemens (ed.), Principles and Practices of Commercial Farming, (Second Edition), Faculty of Agriculture and Home Economics, The University of Manitoba, Winnipeg, 1968, Table 13.35.

at a live weight of less than five pounds, chickens of both sexes may be marketed as broilers. At weights greater than five pounds the chickens, predominantly cockerels, are marketed as roasters. Generally, roasters fall in the age group thirteen to sixteen weeks.

Poults placed for turkey production are of two types, broiler weights and heavy weights. Broiler poults are of mixed gender and achieve a marketable live weight of less than twelve pounds at fourteen to fifteen weeks of age. Poults placed for production of heavy weight turkeys may also be of either sex. Hen turkeys mature to a live weight of fifteen to seventeen pounds in nineteen to twenty-one weeks, and tom turkeys are marketed at twenty-four to twenty-eight pounds after twenty-one to twenty-five weeks. Hens and toms may also be referred to as mediums and heavies, but this need not always identify their gender since toms are sometimes marketed at lighter weights. To be completely accurate it must be noted in this study that the hen and tom categories are not composed exclusively of female and male birds, weight being an over-riding factor.

Dressed and Eviscerated Weights

Poultry carcasses which have had only the blood and feathers removed before sale to the final consumer are referred to as New York dressed. Poultry carcasses from which the inedible viscera, head, feet, feathers, and blood have been removed are referred to as eviscerated. The two

weights may be compared by use of the conversion ratios given in Table VI.

TABLE VI

YIELDS OF POULTRY MEAT CLASSES

Class	Live to Eviscerated	Dressed to Eviscerated
	Percentages	
Broiler chicken	75	87
Roasting chicken	73	84
Broiler turkey	78	89
Hen turkey	81	91
Tom turkey	82	91

Source: Weights and Conversion Factors for Canadian Agricultural Products, Publication 1155, Economics Division, Canada Department of Agriculture, Ottawa, 1962, p. 20.

Incubation Period

The incubation period refers to the time during which the eggs from hatchery supply flocks are kept in special climate-controlled incubators for the purpose of hatching. The incubation periods for chickens and turkeys are twenty-one and twenty-eight days respectively.

Production Period

For the purposes of this study, the production period will cover the time during which the chicks and

poults are under the management of a grower. Hence the production period will be equivalent to the age at maturity for each poultry category.

Five segments of the Canadian poultry meat industry can be identified:

1. Breeding and hatching enterprises;
2. Growing enterprises;
3. Poultry feed industry;
4. Poultry processing industry;
5. Retailing and distributing agencies.

To provide some perspective in further discussions the industry may be viewed in capsule form. The poultry breeders supply the hatchery supply flocks with their most recently developed strains for the production of meat birds. The eggs from these flocks are transferred to hatcheries where they are placed in incubators for the required time. The grower purchases the chicks and poults from the hatchery, broods them artificially, then provides them with the specialty feeds required throughout the maturing period, usually obtained from a local feed dealer. When the birds reach the desired market weight they are shipped to a processing plant, where they are killed, eviscerated, graded, packed in fresh or frozen forms, and stored ready for shipment to the broker, the retail firm, or an institutional buyer. From this point the finished product finds its way to the final consumer.

B. REVIEW OF THE LITERATURE

One important reason for analysing demand-influencing factors and price-quantity relationships arises from the need for estimating the price and income consequences of different forms of supply control in agriculture. For example, prices received by turkey producers may be affected if marketing board allocations of quotas for the production of broiler chickens are insufficient to satisfy latent demands for poultry meats. The published results of most demand analyses include empirical estimates of demand parameters such as direct, cross, and income elasticities, or price flexibilities, as well as the methodology and conceptual models employed in determining the estimates. Studies of poultry commodities differ in statistical techniques and choice of variables, according to the specific problem addressed by the researcher, and the level of sophistication in analysis attainable given the constraints in time, facilities, and financing. In the following pages some of the literature pertaining to demand relationships in the poultry industries of Canada and United States, published during the past decade, is reviewed and major highlights of each study are presented.

A study completed in the United States in 1961 by Brandow (3:1961:3), attempted to quantify the demand relationships for twenty-four farm products, some of which

are pertinent to this study. In the first two parts of his model Brandow describes retail and farm level demands for domestic food use, the latter being derived from the retail portion of his analysis. Brandow refers to his model, or structure of demand relationships, as ". . . a synthesized one. The retail part was constructed after examination of earlier statistical studies of demand for particular products and further statistical estimation in this [Brandow's] study." Brandow (3:1961:3-4) admits that ". . . considerable judgment was necessary throughout the work," and that ". . . the complete structure is intended to describe long-run relationships toward which markets tend rather than short-term behaviour." Average 1955-57 prices, margins and market-clearing quantities formed the bases for numerical estimates. At the retail level, Brandow conceptualized a relation between per capita consumption of each food group, and prices of each food, disposable personal income per capita, prices of consumer goods and services other than foods, and changes in tastes and preferences occurring smoothly over time. Initially these variables are expressed as logarithms of their annual values. Table VII summarizes the pertinent results in the form of elasticities and price flexibilities obtained by Brandow.

Many statistical studies of demand use annual time-series data but it is likely that differences in demand exist within the span of a year. In 1961, Stanton

TABLE VII

DIRECT, CROSS, AND INCOME ELASTICITIES OF DEMAND AND PRICE FLEXIBILITIES FOR CHICKEN AND TURKEY OBTAINED BY BRANDOW

	Demand Elasticities for Chicken and Turkey with respect to:					
	chicken	turkey	beef	pork	income	Price[a] Flexibilities
Retail level						
chicken	-1.16	0.12	0.23	0.16	0.37	-0.95
turkey	0.50	-1.40	0.10	0.07	0.49	-0.75
Farm level						
chicken	-0.74	0.08	0.16	0.09	-	-1.49
turkey	0.32	-0.92	0.07	0.04	-	-1.13

Source: G. E. Brandow, Interrelations Among Demands for Farm Products and Implications for Control of Market Supply (The Pennsylvania State University, College of Agriculture, Agricultural Experiment Station, Bulletin 680, August, 1961), p. 3.

[a] Price flexibilities measure the percentage change in price associated with a 1% change in quantity demanded.

(25:1961:1-14) published his results obtained from using quarterly data to identify seasonal demand for broiler chickens in United States in the period 1953-59. Two models were employed. The first permitted the simultaneous determination of prices and per capita consumption of broilers, and included per capita consumption of beef and pork, and discretionary income per capita as explanatory variables. The second estimated per capita consumption directly, using prices of broilers, beef and pork, and discretionary income per capita as independent variables. The equations were conceptualized using the Cobb-Douglas form and were estimated linearly by a logarithmic transformation. Summer demands were found to exceed winter demands for broilers due to the increasing popularity of chicken for outdoor cooking and the decline in competitiveness of turkey and other poultry meats from winter levels. Numerical results are presented in Table VIII.

A study similar to Stanton's was completed in 1962 by Logan and Boles (17:1962:1050-1060) in which emphasis was placed on analyzing the seasonal variations in retail price and consumption of beef, pork, broilers, and lamb in the United States using quarterly data. Several hypotheses relating to the level and slope of demand functions among seasons of the year for the period 1948-1959 were tested. The models were estimated in reduced form with the price of the commodity being considered as the dependent variable.

TABLE VIII

SEASONAL ELASTICITIES OF DEMAND OBTAINED BY STANTON

	Demand Elasticities of Broiler Chicken with respect to:			
	broiler chicken	beef	pork	income
Model I[a]				
winter	-1.26	0.54	1.83	3.66
summer	-2.24	-1.12	0.57	0.31
Model II[b]				
winter	-1.29	0.24	0.95	2.16
summer	-1.20	0.76	0.07	1.09

Source: B. F. Stanton, "Seasonal Demand for Beef, Pork, and Broilers," Agricultural Economics Research, XIII, 1 (January, 1961), 1-14.

[a] Reduced form, price dependent.

[b] Ordinary least squares, quantity dependent.

Explanatory variables included per capita consumption of other meats and personal disposable income per capita. In stages, the models permitted 1) no quarterly variation in level or slope, 2) variations in levels only, and finally 3) quarterly variation in both level and slope. The results of the broiler analysis presented in Table IX were obtained from the second stage.

TABLE IX

QUARTERLY PRICE FLEXIBILITIES AND ELASTICITIES OF DEMAND FOR BROILERS OBTAINED BY LOGAN AND BOLES

	Price Flexibility	Elasticity of Demand [a]
First Quarter	-0.303	-3.069
Second Quarter	-0.360	-2.588
Third Quarter	-0.365	-2.545
Fourth Quarter	-0.317	-2.930

Source: Samuel H. Logan, and James N. Boles, "Quarterly Fluctuations in Retail Prices of Meat," Journal of Farm Economics, XLIV, 4 (November, 1962), 1050-1060.

[a] The magnitude of these coefficients will be reconsidered in Chapter V.

In 1962 a Canadian study of broiler chicken prices and consumption in Ontario was published by Wood (29:1963:49-59). The expansion of demand in Canada in light of declining prices and producer costs and the effects of mass merchandising techniques on demand in Ontario were summarized. Monthly demands were indexed on the basis of monthly prices and price relatives for the period 1953-1960.

During the period June 1959 to December 1960 a brief analysis of the market margin revealed that weekly producer prices varied 0.6 cents per pound for every one cent per pound change in retail prices, and the weekly elasticity of demand at the retail level was found to be -2.07.

Predominating the literature pertaining to the poultry industry are discussions of price-quantity relationships and the seasonal implications of patterns of production. In 1964, two researchers in the United States, Farris and Darley (7:1964:849-856), using monthly farm level data, presented a further analysis of the seasonal pattern of price-quantity relations for broilers in the 1953-1963 period. Their model, similar to that used by Logan and Boles, considered the effect on broiler prices to producers arising from variations among monthly broiler supplies per capita, while holding monthly slopes of the demand function constant but permitting the levels of the function to vary. These limitations were imposed through the use of dummy variables. Monthly price elasticities of demand at the farm level for the 1953-1963 period are presented in Table X.

Another study, published in the United States in 1966 by Bluestone and Rojko (2:1966:43-51) changed the emphasis from broiler chicken to turkey, and from identifying relationships between prices and quantities to price forecasting. The problem that was examined required accurate price forecasts to enable producers to decide at

TABLE X

ESTIMATES OF MONTHLY PRICE ELASTICITIES OF DEMAND FOR BROILERS AT THE FARM LEVEL, 1953-1963, OBTAINED BY FARRIS AND DARLEY

Month	Estimate of Price Elasticity
January	-1.36
February	-1.31
March	-1.27
April	-1.13
May	-1.04
June	-0.99
July	-0.98
August	-0.97
September	-0.96
October	-0.99
November	-1.08
December	-1.11

Source: Paul L. Farris, and Richard D. Darley, "Monthly Price Quantity Relations for Broilers at the Farm Level," Journal of Farm Economics, XLVI, 3 (1964), 849-856.

which weight to take their birds to market, whether to custom process and store the birds for later sale, or to accept growing contracts at specified prices. The year was divided into two marketing periods, January to August, and September to December. The significant variables affecting determination of turkey prices in the January to August period were per capita supplies of turkey and per capita supplies of chicken. In the main marketing period, from September to December, the significant variables were found to be per capita turkey supplies, and change from year-earlier January to August levels in per capita poultry meat consumption. Price elasticities of demand, computed for comparison purposes, and covering the period 1955-1964 were -2.0 in the January to August period, -0.5 during September to December, and -0.7 throughout the year. The differences confirm that, outside the holiday period, turkey competes more directly with chicken for the consumer's food dollar.

In 1967 a Canadian researcher, Emmery (5:1967), published the results of a study which dealt with determination and forecasts of factors influencing demands for poultry meats for the period 1966-1980, based on analysis of the period 1949-1965. Estimates of market clearing quantities, and farm and retail prices were generated with projected supply and demand equated within the model. Major causal factors influencing demand were population growth, increases in consumer disposable income, and prices of poultry and competing meats. Arbitrary

values of income and retail price elasticities, selected from previous studies and deemed to be representative of the period 1949-1965, were 1.0 and -1.3 respectively.

The basic objective of a research project completed by Matthews (19:1968) in 1968 was to analyse the monthly wholesale to retail price relationships for turkey during the period May 1961 to April 1967 in Ontario. Conceptual models were developed for each weight category of turkey, id est broilers, hens, and toms; and structural parameters were estimated by applying multiple regression analysis techniques to these models, in price-dependent, linear forms. Explanatory variables included supplies of turkey and broiler chicken, and beef and pork prices at the producer level. Deflation of the price variables was accomplished using the Wholesale Price Index. The year was divided into two marketing periods in a manner similar to that used by Bluestone and Rojko (2:1966:43-51). The price flexibility coefficients are presented in Table XI. For the second period, covering the months from August to December, the results pertaining to heavy turkey were statistically unacceptable and hence are not included in the table.

In 1970 Soliman (24:1970) presented his results from an analysis of the turkey industry in the United States during the period 1960- 66. His econometric model, using quarterly data, estimated three behavioural relationships - demand, supply, and end-of-quarter inventory. In his

TABLE XI

MONTHLY PRICE FLEXIBILITY COEFFICIENTS FOR CATEGORIES OF TURKEY IN ONTARIO, 1961-1967, OBTAINED BY MATTHEWS[a]

Category	January to July	August to December
Broiler Turkey	-0.07	-0.14
Hen Turkey	-0.04	-
Tom Turkey	-0.14	-

Source: C. B. Matthews, "An Econometric Model for Ontario Turkey Prices" (unpublished Master's dissertation, University of Guelph, 1968).

[a] The magnitude of these price flexibility coefficients will be reconsidered in Chapter V.

formulation of demand, per capita consumption of turkey was determined by deflated farm prices, deflated prices of red meats, per capita real disposable income, and a variable measuring marketing costs. Using ordinary least squares estimation techniques, and allowing both slope and level of the function to vary by quarters, Soliman obtained the elasticities shown in Table XII.

The differing slopes of the demand functions in each quarter show the significance of seasonal variations in demand. During the fourth quarter (holiday season) price elasticity is smallest and income has little effect on consumption.

When the complete model was applied to evaluate industry adjustments in response to changes in predetermined variables, a very important implication for market regulation was revealed: a gain in total revenue accrued to producers if emphasis in supply management was placed on stimulating demand in the off season, and reducing supplies during the holiday season.[2/]

Also in 1970, Yankowski (30:1970:1-10) presented his results from an analysis of the meats economy in

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[2/] It is this kind of information on demand characteristics which is significant to market regulation strategies. While these considerations will not be analysed in depth in this study, a complementary analysis of regulatory implications is being conducted based on this study. See N. L. Longmuir, "Aspects of Regulated Marketing for Agricultural Products: The Case of Poultry Meat" (unpublished Master's dissertation, University of Manitoba, 1972).

TABLE XII

QUARTERLY RETAIL ELASTICITIES OF DEMAND FOR TURKEY IN THE UNITED STATES, 1960-66

Elasticity with respect to:	Quarter 1	2	3	4
Price	-0.5853	-0.9307	-1.1907	-0.4748
Income	1.0743	- a/	1.7367	0.1589
Red meats	-0.7034	- a/	-0.6676	0.6970

Source: M. A. Soliman, Quarterly Econometric Model of the Turkey Industry in the United States (Technical Bulletin 275; Agricultural Experiment Station, University of Minnesota, 1970).

a/ The estimated coefficient was exceeded by its standard error and elasticity was not computed.

Canada during 1949 to 1969. The importance of beef and other meat products in terms of value and quantity to Canadian consumers, and in terms of farm cash receipts to Canadian producers, were described. Then major historical trends in the demand for beef and other meats, and factors related to these trends, were analysed. Multiple regression analysis techniques were employed with the price-quantity functions expressed in quantity dependent, double logarithmic form. For poultry meats it was determined that a 10% change in retail price was associated with a -5.6% change in per capita consumption, and a 10.7% change in personal disposable income per capita. The retail beef and pork prices proved insignificant in explaining variation in per capita poultry consumption although the indicated relationships were negative.[3/] Finally the methodology and requisite assumptions were outlined and used for projecting demand for beef and other meats to 1980.

The final study to be considered here was published in 1971 by George and King (11:1971). A comprehensive analysis of demand for forty-nine commodities and food commodity groups was estimated at the retail level in the United States, using both cross-sectional data (from the United States Department of Agriculture household food consumption surveys of 1955 and 1965) and time-series data (1946-1968). One objective of this study was to obtain a matrix of demand interrelationships, similar to that obtained by Brandow in 1961. The direct,

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3/ This suggestion of complementarity will be reconsidered in Chapter V.

cross, and income elasticities of demand obtained by these researchers is given in Table XIII.

One of the purposes of a literature review is to assist in the formation of hypotheses for further study. At this time, a brief recapitulation of some highlights of the studies discussed in preceding pages is in order. Two salient features reappeared constantly in reviewing the literature:

1. In an absolute sense demand elasticities, with respect to poultry meat prices and consumer income, are inconclusive in nature. Reported price elasticities at the retail level ranged from -0.78 to -3.07 for chicken meats and from -0.47 to -2.00 for turkey meats. Elasticities derived from price flexibilities were even higher. Income elasticities ranged from 0.16 to 3.66.

2. Whether monthly or quarterly data were being analysed, it was discovered that the level of demands for poultry meat varied throughout the year. The magnitude of seasonal variations differed among the studies in which measurement of these fluctuations was attempted.

A third feature, noted for its absence in the literature, is the possibility of a price relationship in effect between the markets for poultry meats in Canada and the United States. The theory underpinning this hypothesis will be developed in Chapter III. Most Canadian studies dealt with poultry meats as a group; consequently, direct applicability of these results to the regulation problem is limited.

TABLE XIII

DIRECT, CROSS, AND INCOME ELASTICITIES OF DEMAND FOR CHICKEN AND TURKEY OBTAINED BY GEORGE AND KING

	Demand Elasticity of Chicken and Turkey with respect to:				
	chicken	turkey	beef	pork	income
Retail level					
chicken	-0.78	0.08	0.20	0.12	0.18
turkey	0.40	-1.56	0.10	0.07	0.77
Farm level					
chicken	-0.60	- a/	0.13	0.07	- a/
turkey	0.31	- a/	0.06	0.04	-a/

Source: P. S. George, and G. A. King, Consumer Demand for Food Commodities in the United States with Projections for 1980 (Monograph No. 26, Giannini Foundation of Agricultural Economics, March, 1971).

a/ not reported.

CHAPTER III

ECONOMIC THEORY AND ANALYTICAL FRAMEWORK

A. ECONOMIC THEORY

Objectives arise out of the examination and analysis of the problematic situation. In this case the problematic situation arose from the observation that the historical roles of price and individual decision-making in the markets for poultry meats are being replaced by degrees of centralized decision-making and administered pricing. This transition process, with its concomitant adjustments, is beset with confusion and uncertainty. According to Salmon (21:1963:77),

> A statement functions as an hypothesis if it is taken as a premise, in order that its logical consequences can be examined and compared with facts that can be ascertained by observation.

In formulating an econometric model for analysis of the demand characteristics of the five categories of poultry meats, several hypotheses are required. The hypotheses chosen for testing have a direct bearing on the objectives of the study. The basis for outlining of hypotheses in an economic study is found in economic theory.

The theory of demand postulates that quantity demanded in a specified period is a function of the price of the commodity, prices of major substitutes and

complements, and consumer income.[1/] Demand schedules, showing the quantities of a good selected at different prices by consumers, may be derived from either the utility function or an indifference map. (Samuelson (22:1967: Chapter V)). In this study neither derivation will be attempted except insofar as the derivation contributes to the discussion. In the first section of this chapter several theoretical concepts will be presented and discussed. The second section is devoted to outlining the conceptual models employed in the analysis.

It is expedient to consider several economic concepts which relate to each category of poultry meat prior to outlining factors which are peculiar to the individual meat categories. The following pages contain discussions of 1) demand elasticities, 2) deflation, 3) interregional price relationships, 4) marketing margins, and 5) price prediction.

1. Demand Elasticities

Elasticity of demand is an important concept in economic analysis. It refers to the responsiveness of the quantity of a product that will be purchased to changes in its own price, the prices of competing products, or changes in consumer income levels, given the demand curve for the

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[1/] The term "quantity demanded" refers to the actual quantity purchased at market prices, while the term "demand" refers to the demand schedule which shows the maximum prices which consumers are willing to pay for given total quantities.

product, id est other determinants of demand held constant. These separate relationships are called own-price elasticity, cross-price elasticity, and income elasticity. Since different commodities use different units of measure, comparisons among commodities are difficult when physical units (bushels, pounds, etc.) are used. Conventionally, elasticities are specified as ratios of percentages, holding all other factors constant, and are therefore dimensionless.

Price elasticity. The most common relationship is the own-price elasticity of demand, or the percentage change in quantity associated with a small (usually 1%) percentage change in price, ceteris paribus. The Law of Demand asserts that an inverse relationship exists between price and quantity demanded of a normal good.[2/] Hence the elasticity of demand with respect to own-price has a negative sign. The range of these coefficients is from zero to minus infinity, traditionally separated into three parts:

1. If the absolute value of the coefficient exceeds one, demand is elastic;

2. If the absolute value of the coefficient is less than one, demand is inelastic;

3. A coefficient of -1.0 represents unitary elasticity and percentage changes in price and quantity are equal.

2/ A normal good is defined as one the demand for which increases as consumer incomes increase.

In general elasticity coefficients vary in magnitude along the demand curve making it technically incorrect to categorize demand for a specific commodity as either elastic or inelastic. This convenience is permitted, however, by conventionally referring to the elasticity within the usual range of prices. A common practise is to compute the elasticity at the arithmetic mean of the observations on price and quantity.

Income elasticity. Economic theory postulates that in general as incomes increase consumers buy more of most products, and when incomes decrease the opposite occurs. The elasticity of demand with respect to income is defined as the ratio of relative change in quantity demanded to the relative change in income, holding other factors influencing demand at a constant level.

In most cases the income elasticity coefficient is positive, but a few commodities have negative income elasticities in the usual range of incomes. Following conventional economic terminology, commodities are designated as luxuries if their elasticity of demand with respect to income exceeds one, necessities if the coefficient is positive but less than one, and inferior goods if their demand response is negative.

Cross-price elasticity. Conventional economic theory postulates that the demand for any commodity is influenced by the prices of available substitutes and

complements. Cross-price elasticities of demand are measures of the responsiveness of one commodity to changes in the price of another commodity. Though not discussed at length here, different types of cross relationships can be identified on the basis of substitution effects outlined in the Slutsky equation. (Henderson and Quandt (13:1958:26)).

When defining cross effects between related commodities the type of relationship depends on the unknown sign of the substitution effect. Two commodities are substitutes if both can satisfy the same need of the consumer; they are complements if both are consumed jointly to satisfy some particular need. In the Slutsky relation the substitution effect is positive for substitute commodities and negative for complementary commodities. For commodities that are independent the substitution effect is zero.

Homogeneity and symmetry conditions. For the individual consumer two important relations between elasticities of demand are described by Wold and Jureen (28: 1953:Chapter VI). The homogeneity condition (or Slutsky-Schultz relation) states that the sum of the cross- and own-price elasticities and income elasticity for a particular commodity is zero. Mathematically

$$E_{i1} + E_{i2} + \cdots + E_{in} + E_{iy} = 0 \text{ for all } i,$$

where E_{i1} = own-price elasticity,

E_{ij} = cross-price elasticity, $j = 2, \ldots, n$,

and E_{iy} = income elasticity.

The symmetry condition (or Hotelling-Jureen relation) indicates the relationship between cross-price elasticities. Mathematically it is stated

$$E_{ij} = \frac{R_j}{R_i} E_{ji} - R_j (E_{iy} - E_{jy})$$

where R_i, R_j = expenditures on i, j as a proportion of total expenditure;

E_{ij}, E_{ji} = cross-price elasticities;

and E_{iy}, E_{jy} = income elasticities.

The symmetry condition, when used in conjunction with two limiting assumptions, and the known value of one cross-price elasticity coefficient, permits estimating the value of the second cross-price elasticity coefficient. It must be assumed 1) that the consumers' expenditures on the two commodities are small known fractions of total expenditure and 2) that the income elasticities for the two commodities are approximately equal. In this case the relation reduces to

$$E_{ij} = \frac{R_j}{R_i} E_{ji} .$$

By employing the homogeneity and symmetry conditions governing demand elasticities, both Brandow, and George and King, were able to develop matrices of demand interrelationships at the farm and retail levels. Although further consideration of the homogeneity and symmetry relations fall outside the terms of reference of the study

at hand, it is useful to note that these relationships could be applied using the results derived in this study. Additional information about elasticities, and the proportion of consumer expenditures on the various poultry meats, would be required. Those results, presented in Chapter IV, which are doubtful or not directly calculated could then be confirmed.

Expenditure elasticity. An income elasticity estimate based on expenditures on a particular commodity rather than on the physical quantity is sometimes referred to as an expenditure elasticity. The reasons for using expenditures in this manner are 1) because data on expenditures are often more readily available and less subject to error than are data on consumption, and 2) because the elasticity of expenditure with respect to income incorporates a price effect due to quality differences as well as the quantity effect.

In the analysis of income effects, for which a model is developed in a later section of this chapter, data relating to both expenditure and consumption were available for chicken and turkey meats. The consumption data set was selected for estimation of the income-consumption relationships in order to maintain consistency with the data used in estimating other market relationships in the overall analysis. Hence a potential study of quality differences envisioned by consumers between the poultry

meat categories was bypassed.

2. Income Elasticity Reconsidered

In the next few pages consideration will be given to alternative methods of computing the elasticity of demand with respect to income. Income elasticities can be measured using time-series data from the market place or cross-sectional data from household budget studies. When using time-series or cross-section data, the elasticity coefficient can be computed from the income slope of the demand relation. Thus the average income elasticity for the i-th commodity is given by

$$e_{iy} = \frac{\partial q_i}{\partial y} \cdot \frac{\bar{y}}{\bar{q}_i}$$

where q_i = consumption of the i-th commodity,

y = income,

and $\frac{\partial q_i}{\partial y}$ = derived income slope from a quantity dependent regression equation.

In theory and practise the two sources of data usually do not yield the same elasticity value, and it is necessary to know the reasons for this difference before choosing one technique over the other.

In an analysis of time-series data the demand relation may be specified in terms of prices of the commodity in question, prices of available substitutes, disposable income, and changes in consumer tastes and preferences. This permits the direct computation of income

elasticity as the partial derivative with respect to income when using a double-log form, or as the product of the income slope coefficient and the ratio of the means of the independent and dependent variables in natural form. In an analysis of budget data, prices will be approximately the same for all consumers and can be assumed to be constant across the sample. Hence the demand relation can be specified in terms of income and relevant demographic factors such as family size, education, and social status. Once again, an elasticity coefficient can be obtained from the income slope. The obvious difference between these two is in the specification of the demand relation.

Different interpretations are required and different magnitudes expected for the demand elasticities obtained from either method. It is assumed that consumers respond to changes in income by adjusting their consumptions immediately. Wold and Jureen (28:1953:227) point out that

> For the large majority of consumers, the income level is fairly stable. Hence if we consider a group of families that is covered by our family budget data, the changes in income that occur in the course of time are on the whole small and infrequent as compared with the existing income differences between the families in the group. We may accordingly conclude that the families have usually adapted themselves to the income level at which they have been recorded, so that budget data primarily reflect the demand pattern in the sense of long run relations to income changes. In other words, the income elasticities derived from family budget data can most immediately be interpreted as long term elasticities.

From the point of view of practical applications of demand analysis these long-term elasticities are more relevant

for many policy decisions than the short-term elasticities obtained using time-series data.

In comparing the two estimates of income elasticity with respect to their relative magnitudes, Wold and Jureen (28:1953:227-230) have shown that the income elasticities of family budget data are smaller than the income elasticities obtained from time-series data. They suggest that the irreversibility of demand functions and the continued introduction of new products tend to depress the income elasticity of family budget data. On the other hand factors which affect demands in the short-run, and which may not be quantifiable, but nevertheless are included in time-series analyses, are rises in levels and standards of living, the introduction of new food products, better marketing techniques and more effective sales promotion.

These two alternative approaches to obtaining estimates of income elasticities have important implications for empirical demand analysis. To choose between them requires consideration of estimation problems, also. Correlation in time-series data between prices and

disposable income leads to the problem of multicollinearity which is known to bias the estimation of parameters. When using time-series data it is necessary either to include shift variables to permit demand elasticities to vary over time or assume constant other relevant factors such as the distributions of incomes, population growth, changes in tastes and preferences, and other phenomena related to the passing of time. Also inherent in time-series analyses are econometric problems such as multicollinearity, with the resultant confounding of the effects of income and other shift variables.

For these reasons it was decided to undertake a supplementary analysis employing data obtained from the 1969 Family Expenditure Survey completed by Statistics Canada to determine estimates of the elasticity of demand with respect to income, then apply the results of this cross-section analysis to the time-series portion of the study. The data covered average weekly expenditures and quantities of food purchases, home produced food, and gifts, for families of two or more by family type and by family income. The sample was designed to reflect all parts of Canada including farm and non-farm families. The term "family" is used synonymously with "spending unit", which is defined as a group of persons living in the same dwelling and dependent on a common or pooled income for the major items of living expense. Family income was obtained for a twelve month period immediately preceding the week

during which quantities purchased and expenditures were recorded. Hence quantity and expenditure figures are representative of the j-th week in 1969 ($j = 1, \ldots, 52$) and income figures cover twelve month periods ranging from January 1968 to December 1969.

Following conventional economic terminology, commodities are classified as luxuries if they are income-elastic, necessities if income-inelastic, and inferior goods if their demand response is negative. An analogous classification of commodities can be made based on elasticities of demand with respect to family size. (Auer (1:1970)). When family size response is elastic, an inferior good is defined, when inelastic the commodity is a necessity, and when negative the item is a luxury. Income and family size elasticities are compared in Table XIV.

Auer (1:1970:10-12) found that larger families spend more and a much larger proportion of their income on food than smaller families. However a doubling or tripling of family size does not double or triple food expenditures for the following reasons:

1. Some foods are luxuries and only a selected few are "absolute" necessities. Demand for most of them is income-responsive even if only to a limited extent.

2. Scale effects, wherein meals for larger families can be prepared more economically than for smaller ones, and substitution effects which permit the choice of less expensive, equally "filling" foods will influence the

proportional income increase.

3. The family age composition varies according to family size, with the proportion of small children being greater in larger families.

TABLE XIV

INCOME AND FAMILY SIZE ELASTICITIES IN RELATION TO CONSUMER DEMAND RESPONSE

	Income Elasticity e_y	Family Size Elasticity e_f
Luxury	$e_y > 1.0$	$e_f < 0.0$
Necessity	$0.0 \leqslant e_y \leqslant 1.0$	$0.0 \leqslant e_f \leqslant 1.0$
Inferior	$e_y < 0.0$	$e_f > 1.0$

Source: L. Auer, "Urban Consumer-Incomes and Food Expenditures" (A paper presented to the fourth annual meeting of the Canadian Economics Association, Winnipeg, June 3, 1970).

Using the cross-sectional data it was possible to define Engel functions in terms of quantities consumed of chicken and turkey, or in terms of expenditures on chicken and turkey meat. According to the choice of dependent variable, two different estimates of income elasticity of demand may be obtained. If quantity consumed is dependent, a measure of the pure income-consumption relationship is found. When expenditure on the good is dependent, the income coefficient can be shown to include a measure of

consumer quality consciousness, assuming that direct correlation exists between the price and the quality of the product. The concept of quality elasticity will not be elaborated since it is of lesser importance to the study at hand.

Consumption of chicken and turkey are hypothesized to be functionally related to family income and family type. Such factors as demand variations between cities and seasons, and prices of major substitutes are assumed to be constant for all areas, months, and consumers. It was not possible to determine consumption relationships for adults, as distinguished from children, and consequently family types are differentiated by the use of dummy variables.[4/] This process permits the intercept term for each family type to vary while maintaining the same marginal propensity to consume (slope) of the function. The income-consumption relationship is formulated as

$$C = f(Y, F)$$

where C = weekly consumption of chicken and turkey meats;

Y = annual income;

and F = family type.

Having shown the advantages of using cross-section data to obtain estimates of income elasticities, it is necessary to discuss a method for imposing the estimated parameters on the time-series models presented in a later

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[4/] An adult is defined to be a person who has reached the age of 16 years.

section of this chapter. It is apparent that the income coefficients obtained in analyses of time-series data differ from the true income slope by amounts attributable to effects of population growth on consumption, and effects of consumers' changing tastes and preferences. Consider the following hypothetical time-series demand relation,

$$Q = \beta_0 + \beta_1 P_1 + \beta_2 P_2 + \beta_3 Y + u_1$$

where Q mnemonically designates quantity demanded of any good, P_1 and P_2 are prices, Y represents the income variable, and u_1 is a random residual. The coefficient, β_3, is to be replaced by the estimate, $\hat{\beta}_3$, obtained from the supplementary cross-sectional analysis. First remove the estimated income effect as follows:

$$(Q - \hat{\beta}_3 Y) = \beta_0 + \beta_1 P_1 + \beta_2 P_2 + u_1$$

then the parameters β_0, β_1, and β_2 can be estimated using ordinary least squares. Finally the relation that is desired may be solved exclusive of income effects.

3. Deflation

Time-series data on prices, income, or market margins, represent the actual value in each year. The price level for a particular commodity in a given year is influenced by supply and demand factors along with changes in general price levels. Different approaches have been suggested to remove the effects of inflation and deflation in the economy from the reported prices and other variables.

A general approach suggested by Foote (8:1958:27), to remove the effect of changes in price level, is to divide the observed data by the Consumer Price Index. In other instances where demands are being considered for items that involve large initial expenditures such as automobiles, changes in the price level may be accommodated by including the Consumer Price Index as a separate variable in the analysis.

Waugh (27:1964:11) agrees that a standard convention is to deflate prices by dividing them by the Consumer Price Index, but suggests that when the analysis concerns only two variables (the quantity consumed and some kind of deflated price) "it may often be convenient to deflate by dividing prices by consumer income."

As Shepherd (23:1968:127-141) points out, no standard technique of deflation is applicable to all problems. The standard process is effective and accurate only if the relation between the price of the good and the "deflator" is in a one-to-one proportion. In the case of poultry meats the market demand curve can be shown to have shifted rightwards and outwards with the passage of time. Factors associated with time include increases in population, increasing preference for poultry meats and increases in consumer disposable income. As well, cost-saving technological innovations have permitted poultry producers to expand their production levels even in the face of declining commodity prices. After considering the

merits of all the above approaches, price and income variables in this study are deflated by the Consumer Price Index. In addition, some production variables are deflated by dividing them by population to account for increases in consumption attributable to the increased numbers of consumers over time. This use of per capita data avoids confusion of the time trend for population with one that might reflect other effects, such as technological change.

4. Interregional Price Relationships

Within conventional economic thought a body of theory has been advanced to explain interactions between spatially separated markets. In reviewing the literature however, no study was found wherein consideration was explicitly made of the interrelationships between the Canadian and United States poultry meat markets. The markets for poultry products in United States and Canada reflect tastes and preferences that are common among North American consumers. As a consequence the poultry products reaching final consumers in either country are similar, if not homogeneous in many cases, in terms of product form. Economic theory postulates that when perfect competition prevails in spatially separated markets the market clearing prices can only differ by the amount of the cost of transferring the homogeneous product between the submarkets. If prices varied by a larger amount, traders within each submarket would force a return to equilibrium

through the process of arbitrage. In this study the Canadian and United States markets for poultry products are hypothesized to be separated by three cost factors: 1) tariff structures, 2) currency exchange rates, and 3) transportation rates.

Each of these costs can be incorporated into the analysis by computing landed prices for commodities being sold in the alternate market. In such a simulation of the arbitrage process, the Canadian importer is viewed as paying 1) the market-clearing price in the United States, 2) a currency exchange rate to ensure a common medium for the transaction, 3) an excise tax or tariff to bring the commodity across the international boundary, and 4) the costs of transportation and storage. Hence importers (in either country) are presumed to base their decisions to import on currency exchange rates, tariff duties, and transfer costs in addition to price differences.

Even within the borders of Canada prices for poultry products vary among regions due to spatial considerations. Other than the costs of transfer

though, there are no constraints imposed on interprovincial trade. Poultry products are permitted to move east-west in Canada with no monetary restrictions. In designing the analytical model, some accommodation of the added costs of currency exchange and excise duty associated with moving poultry meats to and from the neighbouring United States market must be made. It is hypothesized that

importers and exporters of poultry meat react according to the magnitude of the adjusted differential in prices between the two trading nations, the adjustments being undertaken to account for the "artificial" constraints to trade specified above. The differential in prices may be visualized as a band of sufficient magnitude to cover the "artificial" trading costs. If the band remains constant in size no profit incentive exists to stimulate trade; if the band narrows or widens, id est the differential in prices decreases or increases, then importers or exporters are expected to react to the profit stimulus.

5. Marketing Margins

Conventional economic theory specifies that markets have four dimensions "within which producers and consumers are in communication with one another, where supply and demand conditions operate, and the title to goods is transferred." (Bressler and King (4:1970:75)). The dimensions are time, location, commodity form, and ownership. As the commodity passes through each dimension various costs are incurred. Under perfectly competitive conditions the differences in prices at each market level are attributed to such costs. The marketing margin or marketing charge is the difference between the retail price of a product and its farm value, id est the payment to farmers for an equivalent quantity of farm products. Though one pound of a commodity entering the marketing

channel at the farmer's gate differs markedly from one pound of the same commodity crossing the retailer's counter, it is the difference between the exchange prices for these two separate transactions that represents the marketing margin.

Under competitive conditions the magnitude of the margin is just sufficient to cover the costs incurred and the profits enjoyed by all agencies involved in the transfer of products from producers to consumers. The importance of marketing services varies for different commodities. According to George and King (11:1971:55) in general the farmers share decreases as the number of intermediate operations increases.

An understanding of the methods of price determination is essential before the relations between price spreads and prices at different levels of the

marketing system can be categorized. George and King (11:1971:55) referred to five "complete" pricing methods that may be used to set prices at each market level.

1. Cost-plus pricing and average-cost pricing which require the addition of some base cost as a margin to cover profit;

2. The flexible mark-up method permits markup to be varied on the basis of several possible considerations, including demand conditions.

3. Trial and error methods test the appropriateness of several prices and choose the one which yields the best return.

4. Several research methods set a basis for prices through actual market trials in experimental markets.

5. Some prices are set on the basis of intuition.

As well, prices at each level may be set using "partial" pricing methods including price maintenance or price followership. Price maintenance implies that a constant price that has been proven effective is retained for a long period. Price followership implies that prices charged by the "followers" will, in some way, be related to the price charged by a "leader".

Complete pricing methods give rise to margins having an underlying structure and called systematic margins. Non-systematic margins result from partial pricing methods wherein the spread in prices is not functionally related to prices or volumes. Three systematic methods of setting

margins include:

1. The constant percentage spread where the margin (M) is depicted as a constant percentage (say k) of retail (P_R) or farm (P_F) prices. Thus

$$M = k P_R$$

and $$P_R = P_F + k P_R$$

or $$P_F = (1 - k) P_R$$

2. The fixed absolute spread where the margin (M) is a specified amount added to the farm price (P_F) to obtain the retail price (P_R). Thus

$$P_R = P_F + M$$

3. The price spread related to quantity handled where the margin (M) may be specified as a linear function of quantity handled (Q), stated as

$$M = a + b Q$$

Then the relationship between farm (P_F) and retail (P_R) price becomes

$$P_R = P_F + a + b Q$$

Though these three assumptions regarding the behaviour of marketing margins may be applicable to certain situations it seems appropriate to assume that price spreads are determined as a combination of percentage and absolute margins. According to Waugh (27:1964:20)

> many studies of this matter [percentage and absolute spread] in the [United States] Department of Agriculture suggest that the price spreads are neither constant percentages nor constant absolute amounts, but somewhere in between the two.

Here the margin (M) is specified to be a linear function of retail prices (P_R).

In this study the marketing margin is hypothesized to conform to that specified by Waugh, id est

$$M = \alpha + \beta P_R .$$

In evaluating this hypothesis, information explaining the effects of changes in retail prices on the margin can be obtained using the following:

since $M = \alpha + \beta P_R$

and $P_F = P_R - M$,

combining $P_F = P_R - \alpha - \beta P_R$

and $P_F = (1-\beta)P_R - \alpha$.

Given that $\beta = \frac{\delta M}{\delta P_R}$ and $\frac{\delta P_F}{\delta P_R} = 1-\beta$,

Thus $\frac{\delta M}{\delta P_R} = 1 - \frac{\delta P_F}{\delta P_R}$.

6. Price Prediction

Distinguished philosophers and economists such as Nagel (20:1963) and Friedman (10:1953:Part 1) contend that the value of a theory is determined by its ability to predict. The model to be presented in this study is

predicated on economic theory as it pertains to the poultry industry. Hence one evaluation of the model is permitted by consideration of its ability to predict the monthly prices for the poultry meat classes into 1971.

The values of the endogenous variables to be forecasted are explained during the period studied by several exogenous or predetermined variables, built into an interdependent system of structural equations. The model so devised is estimated using multiple regression techniques, then tested using economic and statistical criteria. In predicting prices for subsequent periods the equations developed in the model can be solved using estimated values for the "knowns" appearing on the right hand side of each equation. The simultaneous nature of part of the model requires the use of a two-stage least squares estimation technique. When concerned with forecasting values of the dependent variables on the right hand side of a stage two estimating equation, it is asserted that the first stage of the two-stage least squares framework contributes the maximum amount of information in determining values for these "known" variables. In forecasting 1971 values of the endogenous variables in order to test reliability of the results, actual values of the exogenous variables are used in conjunction with the estimated structural relations.

B. ANALYTICAL FRAMEWORK

According to Fox (9:1953:8) a theoretical framework for the analysis of demand has four major steps. The first involves specifying the system of relationships that is believed to have produced the observed data. The second requires the analyst to ascertain whether these relationships can be identified for purposes of statistical analysis. The final steps include conducting the analysis and interpreting the results.

This section is addressed to the first two steps. In the following pages structural models of the Canadian poultry meat industry are developed to apply to each subclass of poultry meats. The limitations of the models will be discussed along with sources and availability of data. Having completed the first phase, the structural model is reformulated into an econometric model. In this form the identifiability of the parameters of the system can be examined. The chapter concludes with a description of the estimation technique chosen after examination of the econometric model.

In the following pages, presentation and understanding of the equations is facilitated by the deletion of subscripts designed to identify years, months, producers or consumers, and the subclass of poultry meat. It is understood that the equations are formulated in a generalized manner so as to be applicable to chicken or

turkey meat subclasses as the case may be. Where it becomes evident that greater detail is required to explain factors associated with a particular class of poultry meat, the generalized formulation of an equation is expanded in the text.

Ideally an analysis of the poultry meat market would proceed intact from the retail level of the market structure through the wholesale and farm levels, with demands being derived from final consumer to producer. However, preliminary estimations of the industry in accord with such a framework proved infeasible, due to statistical problems of multicollinearity and a lack of data published at the retail level for all poultry meat subclasses. Hence the retail portion of the industry was analysed separately, and factors determined at the retail level were considered predetermined to the wholesale and farm market levels. In effect two underlying models were estimated: 1) the retail level; and 2) the wholesale and farm levels, with retail prices included exogenously.

1. Conceptual Models

Retail model. As noted previously, economic theory states that the quantity demanded in a specified period depends on the price of the commodity, prices of major substitutes and complements, and consumer income, ceteris paribus. To account for changes that occur smoothly over time (such as tastes and preferences of consumers) a trend

variable is often included in the demand function and certain variables may be deflated. In this study, retail demands for chicken and turkey meats are hypothesized to conform to conventional specifications in general, with a few modifications to be noted.

Initially, for monthly periods, the cause-effect relationship of the demand function is assumed to be represented most adequately using a price-dependent formulation. Quantities being supplied to retail markets are conceptualized as pre-determined or fixed for the month being analysed.[5/] From these relationships, price flexibility coefficients can be estimated. A secondary consideration in using price-dependent equations is that they are more suitable for making price predictions once the equations have been estimated.

The variables denoting retail quantity of chicken and turkey meats, assumed fixed during the month being studied, are subjected to two techniques of deflation. The first removes the effect of rising population by a transformation that computes per capita quantities of poultry meats for inclusion in the demand functions. The second removes the effect of rising consumer incomes, through the period being studied, by adjusting per capita quantities by an amount estimated to be the income effect,

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5/ The rationale for estimating demand functions in price-dependent form has been adequately presented by Foote (8:1958:44-51) and Fox (9:1953:28-31).

derived from the cross-sectional analysis explained previously. An inverse relationship is anticipated to exist between prices and deflated quantities of poultry meats. Additional variables, hypothesized to influence retail poultry meat prices, are prices of major substitutes and complements. The retail prices of beef blade roast and pork shoulder roast are included in this study to approximate the effects of beef and pork meats. The selection of these two subclasses is somewhat arbitrary and is prompted by the expectation that these roasts are more likely to be competitive with poultry meats in price levels; as well, the prices of beef blade and pork shoulder roasts will generally move in line with other retail beef and pork prices. As well, the retail price of the alternate poultry meat (broiler chicken or hen turkey) is included as a substitute for the poultry meat being analysed. To allow for effects on Canadian retail poultry meat prices that arise from the United States poultry meat markets, a variable denoting wholesale poultry meat prices in the United States is included. The wholesale prices are considered appropriate since imports and exports of poultry meat occur at this market level. Finally, each of the price variables is subjected to a deflationary transformation using the Consumer Price Index in order to remove the effect of general retail price increases. A positive relationship is hypothesized to exist between prices of poultry meats and prices of substitutes and a negative relation with

prices of complements.

From empirical analysis of these relationships, information can be obtained and compared to the information gathered from the studies reviewed in Chapter II. Other variables are included in the retail price relationships to assess seasonal implications of demand.

The final variables included in the demand relation are shifters, designed to accomodate particular trends. Initially, seasonalities in prices and consumption are examined on a monthly basis by dummy variables which identify the months of the year.[6/] For chicken meat it is hypothesized that during summer months, demands are relatively stronger than during winter months. For turkey meats, those months within which traditional holidays fall, namely Easter, Thanksgiving, and Christmas, are anticipated to exhibit relatively stronger demands than other months. A second trend variable, designed to accommodate annual changes in consumer tastes and preferences is also included.

In summary, retail prices are estimated using the following structural model:

$$P_r = f(PCQ_1, P_r, P_{rb}, P_{rp}, USP_{py}, P_{rpy}, MONTH, TP)$$

where subscripts identify market levels and meat

[6/] Techniques for specifying and interpreting the binary dummies are presented by Tomek (26:1963:814-822). In all cases monthly dummies are measured about the month of January, and are interpreted as deviations from January levels.

categories;[2/] and where:

P_r = deflated retail prices of poultry meat; chicken or turkey;

PCQ_r = per capita, income-adjusted quantities of poultry meats consumed;

P_{rb} = deflated retail prices of beef blade roast;

P_{rp} = deflated retail prices of pork shoulder roast;

USP = deflated United States wholesale prices of poultry meat, either chicken or turkey;

P_{rpy} = deflated retail prices of poultry meat, either chicken or turkey;

MONTH = month of the year;

TP = changes in tastes and preferences over time.

An assumption made earlier was that retail supplies of poultry meat are fixed within one month periods. It follows therefore that retail supply, in the model being developed, should be defined as an identity. Hence for the i-th month, i = 1, . . ., 96

$$Q_{r,i} \equiv Q_{f,i} + (M-X)_i - (INV_i - INV_{i-1})$$

where Q_r = retail supply of poultry meats, either chicken or turkey;

Q_f = farm supply of poultry meats, either chicken or turkey;

M = imports of poultry meats, either chicken or turkey;

[2/] The reader is cautioned against expecting the equations to apply to specific poultry meat categories, and should refer to the text where additional detail and exceptions to generalized formulations are noted. Generalizations of the equations to include all poultry meat subclasses was deemed necessary to enhance brevity.

X = exports of poultry meats, either chicken or turkey;

INV = end-of-month stocks in storage of poultry meats, either chicken or turkey.

To close the system of equations one additional identity is needed to define per capita retail supply of poultry meats. Thus:

$$PCQ_r \equiv Q_r / POPN$$

where PCQ_r = per capita monthly retail supply of poultry meats, either chicken or turkey;

Q_r = monthly retail supply of poultry meats, either chicken or turkey;

POPN = monthly Canadian population.

The retail model, for purposes of statistical identification is summarized in a later section.

Initial estimation of the poultry meat sector attempted to outline a single model covering retail, wholesale, and farm market levels. Considerable difficulty was encountered in closing this model, and the unavailability of data for all poultry meat subclasses further compounded the complexities of the conceptualization. It was decided that the model be divided. Conditions at the retail level were arbitrarily separated from the farm wholesale level, and this portion of the analysis was undertaken with the assumption that those variables explained in the retail model were predetermined or exogenous at other market levels. Then the analysis moved to the farm and wholesale levels with retail forces assumed to be predetermined.

Farm-wholesale model. Having outlined a conceptual structure for estimating retail demands, the next step is to extend the analysis to include wholesale- and farm-level demands. Since the quantity ultimately removed from the market is determined by the final consumer, demands expressed at market levels other than retail must be derived from retail demands. In this section four demands are isolated. To be considered are: 1) the demand for net imports; 2) the demand for inventory holdings; 3) the demand at the wholesale level; and 4) the demand at the farm level. Finally, consideration will be given to factors which determine the quantities supplied to the market by primary producers.

Although Canada is not self-sufficient in the production of poultry meats, both exporting and importing of poultry meat takes place, with United States being Canada's largest trading partner. At different times of the year individual provinces may find it advantageous to export poultry products into the United States. These conditions arise due to the relatively higher cost of transporting poultry meat within this country when weighed against the costs of shipping and paying excise duties into the neighbouring United States market. To facilitate this exposition, import and export markets are aggregated and a model for net imports (total monthly imports minus total monthly exports) is proposed.

The first variable hypothesized to influence the demand for net imports of poultry meats is the price differential between United States and Canada for the subclass of meat being examined. As outlined in the section on interregional price relationships, prices of homogeneous commodities in spatially separated markets are expected to differ by no more than the transfer rate and certain artificial rates imposed by the sovereign body in each country, when perfect competition prevails in each submarket. The price differential is represented by the difference between the Canadian wholesale price and the price at which United States poultry products can be landed in Canada. Hence the landed in Canada price is the United States wholesale price (of the appropriate poultry meat subclass) adjusted for currency exchange and plus the import duty. The magnitude of the price difference is thus affected by excise duties and by the currency exchange rate. To be conceptually sound, it is necessary to develop the price differential variable along with information about transfer costs. One shortcoming of this study is that such information was not available but this shortcoming is not seriously limiting provided that the transfer costs remain relatively constant. A positive direction of influence is anticipated between net imports and the computed price differential since Canada is a net importer of poultry meats. In a situation where exports outweighed imports the opposite direction of influence

would be in effect.

The second factor employed to explain a portion of the monthly variation in net imports is farm production. It is hypothesized that as levels of domestic production vary, or as Canadian self-sufficiency in poultry meat production is more nearly attained, there is a lessening of net import demands to fulfill consumption requirements. This relationship is expected to have a negative slope.

The third factor in the net import relation is end of month inventory levels of Canadian poultry meats. If poultry stocks in storage exceed the level considered to be a "normal pipeline" amount, one alternative to return to normalcy is to increase exports and reduce imports, thus reducing net imports. As a result a negative relationship is expected between these variables.

Finally it is necessary to accommodate variations in net imports occurring within a one year period, and within the eight year period to which the analysis is addressed. Short-term variations are identified using a dummy variable technique to identify each month of the year. Longer term variations are permitted by a slower shifting trend variable which increases according to one year periods.

The summarized monthly net import relation is:

$$(M-X) = f_2 (PDL, Q_f, INV, MONTH, TREND)$$

where (M-X) = net imports of poultry meats;

PDL = the deflated price differential between Canadian wholesale prices of poultry meats and the sum of United States wholesale prices multiplied by currency exchange rates plus excise duties;

Q_f = the quantity of poultry meat (by subclasses) supplied at the farm level by primary producers;

INV = end of month stocks in storage of poultry meats;

MONTH = month of the year;

TREND = changes associated with annual periods.

A second structural equation is required to explain the demand for inventories of poultry meats. According to economic theory one of the dimensions in the marketing of a product is time. When producers (or processors and retailers) are dissatisfied with current price levels, and when they expect future price levels to improve, they have the option of accepting current price levels or of delaying the sale of commodity for a time by placing it in storage. The length of time a commodity may be stored is determined by its perishability. For primary producers, live birds must be marketed within a limited range of time before quality deterioration begins. For processed poultry meat the range is significantly longer since the commodity may be stored in frozen form with little or no quality deterioration for periods of up to nine months.

The traditional nature of demand for certain types of poultry meat, specifically heavy turkeys, increases the desired amounts of meat for consumption at particular times

of the year. In anticipation of increased Thanksgiving and Christmas demands, processing and other intermediate facilities are operated throughout the year with some processed commodity being channelled into inventory holdings. However the primary purpose for storage holdings is to accommodate the vagaries of consumption and production, to stabilize or destabilize product flows as market conditions dictate and to insure against adverse prices or windfall profits.

The first variable hypothesized to explain end-of-month demands for inventory holdings of poultry meat is farm production. The amounts of commodity supplied by primary producers depend in part on the farmers' perception of final demands derived from the retail level. However, production responses to perceived changes in consumer demand are subject to time lags and storage stocks serve to buffer overly optimistic (or pessimistic) expectations of final demand. Different production response time lags are associated with the different poultry meat subclasses. For larger birds, such as hen or tom turkeys, inventory holdings build up to peak levels just prior to periods of strong traditional demands. For smaller birds, such as broiler chickens, fluctuations in storage stocks are relatively smaller within one year periods. Employing this rationale, the inclusion of farm production of poultry meats in the inventory relation serves to explain variations in inventory levels associated with imperfect knowledge of

final demands derived from the retail level by primary producers.

The second variable included in the inventory relation is domestic consumption. Variations in monthly domestic consumption are hypothesized to correlate negatively with variations in inventory holdings. During relatively strong periods of consumer demand, depicted by high levels of domestic consumption, inventory holdings are expected to fall.

End-of-month inventory levels are further hypothesized to be determined by the farm to wholesale price spread. The effect of the farm to wholesale price spread in determining inventory levels stems from the hypothesis that levels of inventory depend on price expectations of producers and wholesalers. It has been claimed that the magnitude of the price spread is partly determined by the number of intermediate processes through which a commodity passes in traversing the marketing system. Using monthly data makes the measurement of intermediate costs impossible, but the magnitude of the monthly spread is indicative of these. A widening spread indicates a potential decrease in farmer's share, and increase in wholesaler's share of the return from the commodity being dealt with; an inventory increase is the result of wholesalers storing the commodity for future price benefits and of farmers selling their production to avoid future price declines.

The next three explanatory variables are hypothesized to account for variations in inventory associated with substitutes or competing products. The retail prices of beef blade roast, pork shoulder roast, and the alternate poultry meats are expected to vary inversely with inventory holdings of the poultry meat being examined. While the prices of red meats and other poultry meats are increasing, the inventory holdings of a particular poultry meat are expected to fall due to the relative price advantage accruing to consumers who select the commodity which is being considered.

The last two variables to be included in the monthly inventory relation are the month of the year and a proxy of annual trend. By employing dummy variable techniques, an estimation of the deviations in inventory levels of different months about a selected month is obtained. Thus variations in inventory associated with seasonal patterns of consumption and production can be assessed. As well, an estimation of changes in inventory levels associated with longer term effects is made possible by the inclusion of a dummy variable to specify the year of the analysis from which observations are obtained. Variations in inventory levels within one year periods obscure the expected direction of influence of monthly dummies; over periods of more than one year inventory levels have generally remained stable.

In summary the monthly inventory relation is

conceptualized as:

$$INV = f(Q_3, Q_f, Q_r, MM, P_{rpy}, P_{rb}, P_{rp}, MONTH, TREND)$$

where INV = end of month stocks in storage of poultry meat subclasses;

Q_f = farm production of the poultry meat subclasses;

Q_r = domestic consumption of the poultry meat subclasses;

MM = deflated farm to wholesale price spread;

P_{rpy} = deflated retail price of the alternate poultry meat to the class being examined;

P_{rb} = deflated price of beef blade roast;

P_{rp} = deflated retail price of pork shoulder roast;

MONTH = month of the year;

TREND = changes associated with annual periods.

The next behavioural relationship to be estimated is monthly variation in wholesale prices. Most poultry products in Canada are distributed through the wholesale level whether they originate at the time of sale from domestic production, imports, or inventory decumulation. The first variable hypothesized to explain variation in wholesale prices is per capita domestic disappearance. Since wholesale demands are derived from retail demands it is hypothesized that the relationship will be negative. Wholesale prices of poultry meat subclasses are further hypothesized to be influenced by variations in monthly retail prices. The marketing services performed between the wholesale and retail levels imply an additional cost to the

final consumer. Hence wholesale prices are hypothesized to be positively related to retail prices.

Variations in month end inventory levels are expected to explain a portion of the variation in wholesale prices. Large quantities held in storage, with concomitant storage charges, may serve to depress wholesale prices. The relationship is expected to be negative.

The next three variables included in the wholesale price relation are expected to account for variations associated with substitutes and competing products. Retail beef and pork prices and the retail price of the alternate poultry meat are included, with an anticipated positive relationship. Increases in the retail prices of these substitute goods are expected to discourage consumers from purchasing them. The relatively lower price of the commodity being examined should serve to strengthen current demands and help to clear the market.

The final variables conceptualized to account for variations in wholesale prices are month of the year and annual trend. They are included in the wholesale price relation for the same reasons that justified their inclusion in earlier demand relations.

In equation form the wholesale price relation becomes:

$$P_w = f_4(PCQ_r, P_r, INV, P_{wpy}, P_{rb}, P_{rp}, MONTH, TREND)$$

where P_w = deflated wholesale prices of poultry meat subclasses;

PCQ_r = per capita domestic disappearance of poultry meat subclasses;

P_r = deflated retail prices of poultry meats;

INV = month end stocks in storage of poultry meat subclasses;

P_{wpy} = deflated wholesale prices of alternate poultry meat subclasses;

P_{rb} = deflated retail price of beef blade roast;

P_{rp} = deflated retail price of pork shoulder roast;

MONTH = month of the year;

TREND = changes associated with annual periods.

The last demand equation to be estimated is the farm price relationship. Demand at the farm level for poultry meats is derived from retail demands. Since Canada is a net importer of poultry products the supply of poultry meats to the retail level in a month may be derived from any of three sources: 1) farm production, 2) imports, and 3) inventory decumulation. It is hypothesized that the derived demand for farm production and the demand by wholesalers for storage stocks are jointly determined with farm prices. For reasons cited earlier the prices paid to producers are treated as the dependent variable. A negative relationship is expected between farm prices and demands for immediate processing and consumption, and demands for processing and storage for future consumption.

Another factor expected to influence farm price is the price of imported poultry meat products. A major proportion of Canadian poultry imports originate in the

United States. Thus a variable was constructed to approximate the value of poultry imports landed in Canada. As noted earlier, the landed in Canada prices were computed so as to include the effects of currency exchange rates and tariff duties. The relationship between farm prices and landed prices is expected to be positive.

Substitute commodities are expected to compete with poultry meats at both farm and retail levels. The farm prices of beef and pork, and the farm price of an alternate poultry meat are conceptualized to exert positive effects on the farm price of the poultry meat subclass being analysed. Since final demands for poultry meats are determined by consumers, and since the primary producer is insulated from final demands by intermediaries (processors, retailers, transporting agencies), it is necessary that farm level demands be derived from the retail level. In this regard the retail price of the poultry meat being analysed is included in the farm price relation with an expected positive relationship. For reasons cited earlier the month of the year and a proxy of annual trends are also included in the farm price relation.

Therefore, the farm price relation is formulated as:

$$P_f = f_5(PCQ_f, INV, LNDP, P_{fpy}, P_{fb}, P_{fp}, P_r, MONTH, TREND)$$

where P_f = deflated farm price of poultry meat subclasses;

PCQ_f = per capita farm production of poultry meats;

INV = month end stocks of poultry meat subclasses;

LNDP = landed in Canada price of poultry meat imports;

P_{fpy} = deflated farm price of alternate poultry meat subclass;

P_{fb} = deflated farm beef prices;

P_{fp} = deflated farm pork prices;

P_{r} = deflated retail price of poultry meats;

MONTH = month of the year;

TREND = changes associated with annual periods.

The final behavioural relationship in the farm-wholesale model is the farm supply relation. The reasons cited for specifying previous demand relations in price-dependent form recognized the predetermined nature of supply of poultry meats within periods of one month. This premise is further justified by Fox (9 :1953:28-31). For these reasons the farm supply relation is considered to be recursive in the analysis to follow. According to theory, prices of the product and costs of production are included in the supply relation. It is hypothesized however that farmers' production responses are prompted by expectations of prices and costs. Hence farm prices and costs of production are lagged to account for the production period of the particular class of chicken or turkey being considered. Since data representing costs of production are either inadequate or unavailable for each poultry meat subclass, and since the cost of feed occupies a significant proportion of poultry producers' variable costs, it was

necessary to use the cost per hundredweight of feed as a proxy for total costs. The relationship expected between supply and lagged price is positive and between supply and lagged costs is negative.

A third lagged variable included in the farm supply relation is placements of chicks for broiler production, or of poults for turkey production, as the analysis dictates. Variations in the lagged numbers of chicks or poults placed for poultry meat production are expected to explain a portion of the monthly variation in farm supply. The expected direction of influence is positive with increases in lagged placements accounting for increases in farm supply.

The last two variables included in the supply relation are month of the year and annual trend. The first hypothesis being tested is that supplies are associated with months or seasons of the year. The second hypothesis is that the longer-run implications of advancing technology affect supplies over the period being analysed.

The farm supply relation is conceptualized as:

$$Q_f = f_6(P_{f,lag}, C_{lag}, PCMT_{lag}, MONTH, TREND)$$

where $P_{f,lag}$ = lagged deflated farm prices of chicken and turkey meat subclasses;

C_{lag} = lagged deflated prices per hundredweight of poultry feeds;

$PCMT_{lag}$ = lagged placements of chicks or poults;

MONTH = month of the year;

TREND = changes associated with annual periods.

In order to close the system of equations specified in the farm-wholesale model some additional equations in the form of identities must be considered. The identities to be presented have been discussed in the specification of variables for each relation; however to facilitate further exposition they will be summarized at this time.

$$\text{i.} \quad PCQ_f \equiv Q_f / POPN$$

where monthly per capita farm supply is designated as total farm supply deflated by population;

$$\text{ii.} \quad PCQ_r \equiv Q_r / POPN$$

where monthly per capita consumption is designated as domestic consumption deflated by population;

$$\text{iii.} \quad Q_{r,i} \equiv Q_{f,i} + (M-X)_i - (INV_i - INV_{i-1})$$

for i = 1, . . ., 96

where monthly domestic consumption is designated as farm slaughter plus net imports minus the inventory decumulation of the current month;

$$\text{iv.} \quad MM \equiv P_w - P_f$$

where the monthly farm-wholesale price spread is defined as the difference between wholesale and farm prices;

$$\text{v.} \quad LNDP \equiv (USWP \times EXCHG) + TARIFF$$

where monthly landed price in Canada is defined to be the product of United States wholesale price and the currency

exchange rate, plus the import tariff duty;

$$\text{vi. } PDL \equiv P_{W} - LNDP$$

where the monthly price differential is defined to be the difference between the Canadian wholesale price and the price of United States poultry meat landed in Canada.

The relationships, which together make up the models to be analysed, contain a set of variables for which solution values can be derived. Alternatively, imposed on the variables are restrictions in the form of mathematical equations which, when solved, will yield equilibrium values for the variables given a set of parameters. The parameters (whose values locate the system in space) have been defined by closing the system using a series of identities. The models which have been conceptualized above are expressed in econometric form for discussion of estimation characteristics at the end of this chapter.

2. Limitations

The conceptualization of the system of relationships believed to operate in the Canadian poultry industry has been facilitated by frequent references to postulates of economic theory. Having theorized the model in this manner, the next step is to determine whether data are available for empirical testing of the constructed system. Much of the theory pertaining to the formulation of the model was derived using rigid assumptions. The theory assumes that utility functions among consumers shift systematically over time;

that perfect knowledge is employed in making consumption and production decisions; that commodities being purchased are homogeneous among consumers; that adjustments in prices and incomes are instantaneous; that the distribution of incomes among consumers and between regions is stable; and that the market environment is perfectly competitive. These assumptions are unlikely to be satisfied in empirical situations.[8/] When employing time-series data a single point common to both demand and supply schedules is obtained. This point defines the market-clearing price and the quantity exchanged at that price. Also the nature of time-series violates the concept of instantaneity by permitting variations associated with temporal changes in basic phenomena. If cross-section data are employed, the strata may violate one or more of the ceteris paribus conditions used in the theoretical derivations. In empirical formulations these problems are alleviated by introducing shift variables to permit interseasonal and other variations over and above the simple theoretical price-quantity relationships; or by the use of stochastic models incorporating an error term to allow for random, unspecified variation. In succeeding pages the sources and availability of data to satisfy the conceptual model are presented.

3. Data Availability and Sources

The scope of this study makes apparent the need for a great deal of data on prices and quantities of poultry

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8/ Whether the poultry meat markets are perfectly competitive or not is discussed further in Chapter V.

meat at each market level in Canada. The division into monthly analyses further complicates data collection. Since the study is concerned with the five major poultry meat categories, one objective used in choosing data series was the ability to distinguish each subclass of poultry meat. A second objective was to ensure that the study period was of sufficient length to permit production cycles to traverse their entire amplitude.

Physical quantities demanded and supplied were obtained from data published annually by the Canada Department of Agriculture in the Poultry Market Report. Production figures were measured as the numbers of pounds eviscerated weight of chicken (or turkey) slaughtered in registered stations in Canada. It is not known what proportion of actual Canadian production passes through this country's registered processing stations, but it is assumed that a major portion of production is marketed through this medium. A further necessary assumption was that the unknown proportion remained constant over the time period studied. Aggregate consumption figures were determined from estimates of domestic disappearance.

Retail prices of the major substitutes, beef and pork, were obtained from Prices and Price Indexes, published by Statistics Canada (formerly Dominion Bureau of Statistics). Prices paid to producers of poultry were found not to be published in the necessary form and had to be derived. For the period 1963-1970, average poultry

producer prices were obtained by summing provincial total revenue from sales of the poultry meat subclasses and dividing by monthly Canadian total production. Farm prices of cattle (a weighted average) and hogs (index 100) were obtained from the Canada Department of Agriculture publication, Livestock Market Review. Per capita disposable consumer incomes were obtained from National Accounts, Income and Expenditure, (No. 13-20), published annually by Statistics Canada.

In the retail portion of the monthly study, data were available which permitted broiler chicken and hen turkey subclasses to be identified for the period 1961-1970. Estimation of the other subclasses was not permitted since prices at the retail level for roasters, broiler turkeys, and tom turkeys are not available. The available retail poultry prices, and the prices of beef and pork substitutes were obtained from Statistics Canada, as published in Prices and Price Indexes.

Monthly quantities of broiler chicken and hen turkey consumed were derived as the sum of farm production plus net imports minus net change in end of month inventory. Farm production was measured as receipts at registered stations in Canada, obtained from the Canada Department of Agriculture Poultry Market Review. Net imports of chicken and turkey were obtained by subtracting exports of the appropriate meat type from imports in a given month. Neither exports nor imports were available on the basis of poultry meat

subclasses and the data chosen were published in the Poultry Market Report. End of month inventories were derived from beginning of month inventories as published by Statistics Canada in Stocks of Dairy and Frozen Poultry Products, (No. 32:009). Monthly per capita consumptions of chickens and hen turkeys were then derived from the aggregate consumption figure by dividing by monthly population.

Monthly Canadian population, and monthly per capita disposable income data are not published and must be derived from annual estimates. In this study a simple linear approximation was used wherein beginning and end-of-year figures were compared, their difference divided into twelve equal increments and added cumulatively to the months of the year. Annual estimates of population and disposable income were obtained from Statistics Canada publications 91:201 and 13:201 respectively. The farm-wholesale portion of the monthly study was estimated for the period 1963-1970, covering all five subclasses of poultry meats. Since neither farm price nor wholesale price were published in usable monthly form, both had to be derived. Wholesale prices were obtained as the prices determined in London, Ontario in the last week of the month for each subclass and for each month, and published by Canada Department of Agriculture in the weekly Poultry Market Review. Farm prices, as noted above, were derived by summing total revenue for each category of poultry

across provinces and dividing this total by Canadian monthly production of the appropriate subclass of poultry meat. Provincial data on monthly prices to producers and farm production were obtained from the Poultry Market Report.

Monthly wholesale prices of poultry meat products in the United States were obtained from the United States Department of Agriculture, as published annually in Poultry Market Statistics. In computing the Canadian-United States price differential, it became necessary to obtain currency exchange rates and excise tariffs. The foreign exchange rate, taken as the monthly average of "noon spot" prices, was obtained from the Statistical Summary and Financial Supplement of the Bank of Canada. Tariff rates were obtained by the author in correspondence with the Marketing and Trade Division of the Economics Branch of Canada Department of Agriculture.

The monthly costs of poultry feeds for the period 1963-1970 were assumed to approximate costs of production of each of the subclasses of poultry. In this regard, the cost of chicken starter and grower, broiler starter and turkey grower feeds were collected from Prices and Price Indexes, published by Statistics Canada. Monthly placements of chicks and poults for broiler production, and of poults for heavy weight turkey production were obtained from annual issues of the Poultry Market Report.

4. Identifiability

A preliminary step to empirical analysis is to outline the structure of the poultry industry in a series of conceptual models. Having satisfied this requirement, it is then necessary to specify the models in a statistical format for further examination of the mathematical relationships. Since the form of the functional relationship is not specified by theory, some preliminary analyses were completed to obtain information on which the choice of linear or curvilinear relations could be assessed. As well, the results of a correlation analysis were used to justify replacing some variables in the conceptual model due to excessive multicollinearity.

The question of identification in the context of simultaneous equation systems ultimately comes down to the ability to estimate unique values for each parameter of the model, from the knowledge about the population of observations of which the data is presumed to constitute one sample. If this knowledge permits deduction of unique estimates, the relation is said to be identified; if it does not, the relation may be overidentified if more than one estimate exists, and underidentified if it cannot be solved for a unique estimate.

The choice of an estimation technique is based on two criteria:

1. The chosen method must have the ability to deal

with the identification problem in simultaneous equation systems;

2. The parameter estimators, or statistics, developed by the chosen technique must have the statistical property of "goodness". According to Yeh (31:1964:2-5) there are four characteristics of an estimator or statistic which define its relative "goodness".

i. Unbiased - the statistical estimate converges on the true value for the population with repeated sampling and samples of the same size. The expected value of the estimator is identically equal to the population parameter;

ii. Consistent - the statistical estimate converges on the true value for the population as the sample size grows;

iii. Efficient - the statistic exhibits the smallest variance among all possible estimators;

iv. Sufficient - the statistic contains all the information available in the given sample.

It is not necessary to examine the identifiability of each of the models to determine acceptable estimation techniques since the monthly retail model is not determined simultaneously; hence ordinary least squares estimation will result in best linear unbiased estimates of the parameters. At the farm and wholesale levels the relationships are hypothesized to be determined simultaneously, and the identification of this system of equations will serve to place constraints on the estimation

procedures that are available in order to achieve the desired "goodness" criteria.

The necessary condition for identification, presented by Johnston (15:1963:251), is that the number of variables not contained in a particular equation but appearing elsewhere in the model must be one less than the number of endogenous or dependent variables. Symbolically

$$K^{**} + G^{\Delta\Delta} \geq G - 1$$

where K^{**} = the number of exogenous variables in the system but excluded from the particular equation;

$G^{\Delta\Delta}$ = the number of endogenous variables in the system but excluded from the particular equation;

G = the number of endogenous variables in the system.

The relation is considered just-identified if the equality is true, and over-identified if the inequality is true (id est the left hand side exceeds the right hand side of the relation).

5. Summary of Econometric Model

In succeeding pages the conceptual systems developed earlier are reformulated into statistical models. In stating the models the variables are designated as exogenous if they are determined outside the sphere which the model purports to explain, or endogenous if the model is used to account for their values. A designation of 'y' for endogenous, 'x' for exogenous and 'z' for predetermined

variables is substituted for previous mnemonic designations.

The variables to be analysed in the retail monthly models for both broiler chicken and hen turkey subclasses are the same except insofar as they pertain to the individual poultry meat subclasses. For broiler chickens the mathematical specification of the relationship was found in preliminary runs to be curvilinear in absolute form, thus linear in the logarithms of the variables. The hen turkey relationship is specified to be linear in absolute terms.

The retail monthly demand for broiler chickens is represented as

$$\log y_{1,1} = \log a_1 - b_{1,0} \log y_{1,2} + b_{1,1} \log x_{1,1} + b_{1,2} \log x_{1,2} + b_{1,3} \log x_{1,3} + b_{1,4} \log x_{1,4} + \sum_{m=5}^{15} b_{1,m} x_{1,m} + b_{1,16} x_{1,16} + \log u_1 ;$$

and for hen turkeys the relation is the same but not in logarithms

$$y_{2,1} = a_2 - b_{2,0} y_{2,2} + b_{2,1} x_{2,1} + b_{2,2} x_{2,2} + b_{2,3} x_{2,3} + b_{2,4} x_{2,4} + \sum_{m=5}^{15} b_{2,m} x_{2,m} + b_{2,16} x_{2,16} + u_2 .$$

Retail monthly supplies of poultry meats ($j = 1,2$) are considered to be predetermined in the month at hand, but are included in the model as an identity with domestic

supply specified for the i-th month as

$$y_{j,3,i} \equiv x_{j,17,i} + x_{j,18,i} - (x_{j,19,i} - x_{j,19,i-1}),$$

for i = 1, 96, and per capita consumption as

$$y_{j,2} \equiv y_{j,3} / x_{j,10} .$$

Variable Designation

Endogenous.

$y_{i,1} = P_r$: deflated retail prices of broiler chickens or hen turkeys;

$y_{i,2} = PCQ_r$: per capita, income adjusted quantities of broiler chicken or hen turkey consumed;

$y_{i,3} = Q_r$: retail supply of broiler chicken or hen turkey;

Exogenous

$x_{i,1} = P_{rb}$: deflated retail prices of beef blade roast;

$x_{i,2} = P_{rp}$: deflated retail prices of pork shoulder roast;

$x_{i,3} = USP_{py}$: deflated United States wholesale prices of broiler chickens or hen turkeys;

$x_{i,4} = P_{rpy}$: deflated retail prices of the alternate poultry meat as a substitute commodity;

x_m, m = 5, . . ., 15 = MONTH : a dummy variable to designate the months February to December inclusive;

$x_{i,16} = TP$: changes in tastes and preferences over time;

$x_{i,17} = Q_f$: farm supply of broiler chickens or hen turkeys;

$x_{i,18}$ = (M-X) : net imports of chicken or turkey;

$x_{i,19}$ = INV : month end storage stocks of broiler chickens or hen turkeys;

$x_{i,20}$ = POPN : monthly Canadian population.

Having completed the separate analysis of the retail model, the study proceeds to other market levels using the assumption that prices explained in the retail model are predetermined to other market levels. The farm-wholesale model, containing five structural equations and six identities is represented as follows where i subscripts identify poultry meat subclasses:

net import relation

$$y_{4,i} = a_{3,i} + b_{3,1,i} y_{5,i} - b_{3,2,i} z_{1,i} - b_{3,3,i} y_{6,i} + b_{3,4,i} x_{16} + \sum_{m=5}^{15} b_{3,m,i} x_{m,i} + u_{3,i} ;$$

for i = 1, . . ., 5

inventory relation

$$y_{6,i} = a_{4,i} + b_{4,1,i} z_{1,i} - b_{4,2,i} y_{9,i} - b_{4,3,i} y_{11,i} + b_{4,4,i} x_{21} + \sum_{m=5}^{15} b_{4,m,i} x_{m,i} - b_{4,16,i} x_{1} - b_{4,17,i} x_{2} + b_{4,18,i} x_{16} + u_{4,i} ;$$

for i = 1, . . ., 5

wholesale price relation

$$y_{7,i} = a_{5,i} - b_{5,1,i} y_{10,i} + b_{5,2,i} x_{21} - b_{5,3,i} y_{6,i}$$

$$+ b_{5,4,i}\, y_{7,i} + \sum_{m=5}^{15} b_{5,m,i}\, x_{m,i} + b_{5,16,i}\, x_{1}$$

$$+ b_{5,17,i}\, x_{2} + b_{5,18,i}\, x_{16} + u_{5,i} \quad ;$$

for i = 1, . . ., 5

farm price relation

$$y_{8,i} = a_{6,i} - b_{6,1,i}\, z_{2,i} - b_{6,2,i}\, y_{6,i} + b_{6,3,i}\, y_{12,i}$$

$$+ b_{6,4,i}\, y_{8,i} + \sum_{m=5}^{15} b_{6,m,i}\, x_{m,i} + b_{6,16,i}\, x_{22}$$

$$+ b_{6,17,i}\, x_{23} + b_{6,18,i}\, x_{21} + b_{6,19,i}\, x_{16} + u_{6,i} \quad ;$$

for i = 1, . . ., 5

farm supply relation

$$z_{1,i} = \log a_{7,i} + b_{7,1,i} \log x_{24,i} - b_{7,2,i} \log x_{25,i}$$

$$+ b_{7,3,i} \log x_{26,i} + b_{7,4,i}\, x_{16} + \sum_{m=5}^{15} b_{7,m,i}\, x_{m,i}$$

$$+ \log u_{7,i} \quad ;$$

for i = 1, . . ., 5

per capita farm slaughter identity

$$z_{2,i} \equiv z_{1,i} / x_{20}$$

domestic consumption identity

$$y_{9,i,t} \equiv z_{1,i,t} + y_{4,i,t} - (y_{6,i,t} - y_{6,i,t-1})$$

per capita domestic consumption identity

$$y_{10,i} \equiv y_{9,i} / x_{20}$$

wholesale to farm price spread identity

$$y_{11,i} \equiv y_{7,i} - y_{8,i}$$

landed price identity

$$y_{12,i} \equiv (x_{3,i} * x_{27}) + x_{28}$$

price differential identity

$$y_{5,i} \equiv y_{7,i} - y_{12,i}$$

Variable Designation

Endogenous.

$y_{4,i}$	= (M-X)	: net imports of chicken or turkey;
$y_{5,i}$	= PDL	: difference between deflated Canadian wholesale prices and deflated landed in Canada prices;
$y_{6,i}$	= INV	: month end stocks in storage of poultry meat subclasses;
$y_{7,i}$	= P_w	: deflated wholesale prices of poultry meat subclasses;
$y_{8,i}$	= P_f	: deflated farm prices of poultry meat subclasses;
$y_{9,i}$	= Q_r	: domestic consumption of poultry meat subclasses;
$y_{10,i}$	= PCQ_r	: per capita domestic consumption of poultry meat subclasses;
$y_{11,i}$	= MM	: deflated wholesale to farm price spread of poultry meat subclasses;
$y_{12,i}$	= LNDP	: deflated landed in Canada prices of poultry meat subclasses;

Exogenous.

x_1	= P_{rb}	: deflated retail prices of beef blade roast;

$x_2 = P_{rp}$: deflated retail prices of pork shoulder roast;

$x_3 = USP_{py}$: deflated United States wholesale prices of poultry meat subclasses;

x_m, $m = 5, \ldots, 15$ = MONTH : dummy variables to designate the months February to December inclusive;

x_{16} = TREND : dummy variables to accommodate changes associated with annual periods;

x_{20} = POPN : monthly Canadian population;

$x_{21} = P_{rpy}$: deflated retail prices of the poultry meat subclasses;

$x_{22} = P_{fb}$: deflated weighted farm price for cattle;

$x_{23} = P_{fp}$: deflated farm prices of index 100 live hogs;

$x_{24,i} = P_{f,lag}$: deflated, lagged farm prices of the poultry meat subclasses;

$x_{25,i} = C_{lag}$: deflated, lagged costs per hundredweight of poultry feed;

$x_{26,i} = PCMT_{lag}$: lagged placements of broiler chicks or poults;

x_{27} = EXCHG : the exchange rate for United States currency represented as the monthly average of "noon spot" prices;

x_{28} = TARIFF : excise duties paid when importing poultry meats from United States;

Predetermined.

$z_{1,i} = Q_f$: farm production of poultry meat subclasses;

$z_{2,i} = PCQ_f$: per capita farm production of poultry meat subclasses.

6. Econometric Methodology

The conceptualization of section i of this chapter was carried out in the deterministic environment that characterizes many theoretical models. If it were certain that all conceivable variables and relationships were specified, the thesis could have ended at that point. As a matter of practical fact, however, one may be sure that the specification is not entirely complete and that excluded factors will tend to create observed disturbances from the model. Thus, in relating the model to the empirical world one must be ever-conscious of a stochastic component.

In the previous section the model was summarized into its econometric form, with the unspecified stochastic components accounted for by the inclusion of an error term in each behavioural relationship. Several techniques are available to relate the deterministic model to the empirical (and therefore stochastic) world. Listed in approximately decreasing order of statistical efficiency and computational complexity these are

i. Full information - maximum likelihood;

ii. Limited information - maximum likelihood;

iii. Three stage least squares;

iv. Two stage least squares; and

v. Ordinary least squares.

Using any of these techniques, estimates can be derived which are biased, consistent estimates of structural parameters in that the statistical estimate converges on the true value for the population only with repeated sampling and samples of the same size.

For the analysis of relationships at the retail level in this study the method of ordinary least squares is deemed applicable. According to Lee (16:1963:29-49) the following assumptions are necessary with regard to the regression model:

i. $Y_i = \alpha + \beta X_i + \epsilon_i$, for all i;

ii. $E(\epsilon_i) = 0$, for all i;

iii. $E(\epsilon_i \epsilon_j) = 0$ for $i \neq j$, $j = 1, 2, \ldots, n$;
$= \sigma^2$ for $i = j$, $i, j = 1, 2, \ldots, n$;

iv. $E(X_i, \epsilon_i) = 0$

According to Johnston (15:1963:231-268), if these assumptions are satisfied the estimators will be "best linear unbiased", thereby satisfying the "goodness" criteria outlined earlier.

Applying the methods presented in section iv of this chapter to each of the stochastic relations of the farm-wholesale model, each of the relations is revealed to be overidentified. A suitable estimating technique must be

used in solving systems of overidentified simultaneous equations. Thus, for the analysis of relationships at the farm and wholesale levels in this study the method of two stage least squares is accepted because it provides consistent estimates and is feasible for an analysis of this size. The fundamental difficulty in simultaneously determined models is correlation between the disturbance term, u_i, and the explanatory variables.[7] The justification for two stage least squares is the consideration that all of the variables in a simultaneous system influence in some way each of the endogenous variables. The objective of the two stage least squares technique is to purge the explanatory variables of stochastic components associated with the disturbance term, u_i. This is accounted for in the first stage when the matrix of included endogenous variables in each relation is replaced by an estimated set which is independent of the disturbance terms. The second stage involves the direct estimation of the structural equations using estimated values of the endogenous explanatory variables plus the original data for exogenous variables. While the structural estimates provided by two stage least squares regression techniques remain biased, it is noted that the sample size being dealt with throughout this study might be

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[7] The seminal article on simultaneous equation problems is T. Haavelmo (12:1943:1-12).

considered "large" ($n = 96$), imparting relatively more importance to the consistency property of the two stage approach.

CHAPTER IV

RESULTS OF ANALYSIS

In previous chapters the structure of the Canadian poultry meat industry has been discussed. As well, the results obtained by other researchers have been surveyed and incorporated into the study. Models were developed at the retail, and farm-wholesale market levels in which the economic factors influencing the poultry meat industry in Canada have been explained. The primary concern of this chapter will be to present the results obtained from applying these models to empirical analyses. In the first section the statistical tests used to assess the validity and usefulness of the models will be discussed. In some cases economic considerations will be weighted to over-ride statistical criteria. The second section is devoted to tabular and graphical presentations of the results. In the third section the results will be interpreted.

A. STATISTICAL CRITERIA

In the jargon of statistics a Type I error is defined as the rejection of an hypothesis which, in fact, is true. To facilitate the assessment of hypotheses it is necessary to establish a level of tolerance which permits

one to commit Type I errors, but does not detract from the merit of the analysis. In this study, null hypotheses will in general be accepted if there is in excess of a ten percent possibility that they are correct. Stated alternatively, a one in ten chance of rejecting a true hypothesis will be tolerated. In some cases economic considerations must be favoured in the absence of statistical significance.

In determining significance of net regression coefficients, the results are subjected to student-t tests. Without going further into theoretical detail, this test requires that the coefficient exceed its standard error by an amount the magnitude of which determines the level of significance. When evaluating hypotheses regarding influence but not direction of effects it is necessary to use both tails of the student-t frequency distribution; for other hypotheses, where the direction of influence is the object of concern, one-tailed tests are performed.

Further statistical information is obtained in the analyses in the form of standard errors, correlation coefficients and multiple coefficients of determination. As well the Durbin-Watson and Von Neumann tests for autocorrelation will be performed. The Von Neumann ratio is used to determine if successive residuals (<u>id est</u> differences between estimated and actual values of the dependent variable) are correlated with previous values in a given series of residuals. This test is deemed superior

to the Durbin-Watson test because no inconclusive results are derived. In this analysis, however, the numbers of variables in some relations approach twenty, which is well beyond the maximum number that published tables will accommodate. Though computations could have been undertaken to derive relevant ranges on which to test for the presence of autocorrelation, such a procedure was considered to be outside the scope of this project. For a lucid explanation of statistical tests and definitions refer to Ezekiel and Fox (6:1959) or to the other texts cited in the bibliography.

As a word of caution, since the presence of autocorrelation in the behavioural relations will not be corrected, it is necessary to be aware of possible biases in the measurements of standard errors of estimates. Positively autocorrelated residuals will cause the standard errors of regression coefficients to be biased downward; thus the possibility of achieving statistical significance of coefficients is enhanced, though unwarranted. The implication that student-t tests and confidence intervals are invalid will be pursued when the results are being interpreted. Oftentimes the presence of autocorrelation in econometric analysis is evidence of one or more missing variables. To ensure that estimates of structural parameters drawn from these relationships are unbiased and consistent it is necessary that the missing variables not be correlated with any variables included in the

explanatory equation. In this study it is assumed that such is the case. For additional detailed discussion of missing variable problems in econometric analysis the reader is referred to Johnston (15:1963:177-201).

Before proceeding with the presentation of results it should be recalled that data being analysed were subjected to a process of deflation to remove the effects of changes in general price levels and the growth of population over time. For price variables the Consumer Price Index is the deflator. For production variables, where applicable, Canadian monthly population is used. As a consequence, attempts to apply the model to current periods must be preceded by adjustment of data for general price increases and population growth.

B. PRESENTATION OF RESULTS

In this study three models have been developed for poultry meats, and the poultry meat subclasses wherever possible, which are designed to explain 1) income-consumption relationships, 2) retail demands, and 3) the farm-wholesale portion of the market structure. In this section the results obtained from empirical analysis of these models will be presented. For purposes of minimizing reader confusion, and to ensure clarity as well as brevity in presenting the proliferation of coefficients, signs, statistical significances and elasticities, it is necessary that a practical system for presentation be devised.

Clearly, the models may be presented individually. As well, the lack of data for each subclass of poultry meat, constrains the analysis of the income-consumption and retail price models to comparisons of broader classifications of poultry meats. For the farm-wholesale model, data representing each of the five subclasses of poultry meat were available and empirical estimates of each of the five behavioural relationships (and six identities) were obtained.

To promote coherency between models the same technique of presentation is necessary for each. To promote coherency between the poultry meat subclasses in the farm-wholesale model, each of the five meat types will be dealt with conjointly in light of a single behavioural relationship. In setting forth the results of each model the estimated coefficients, their student-t tests, and elasticity values, where pertinent, will appear in tabular form. Included in these tables will be monthly dummy variables (family size effects in the income-consumption relation), with those dummy variables that achieve statistical significance being presented in graphical form as deviations about a selected base immediately following the tables. Finally the results for each model will be discussed. In this discussion two objectives are sought: 1) to evaluate the hypotheses which were posited in formulating each model; and 2) to compare the results obtained amongst poultry meat subclasses. Economic as well

as statistical considerations will play a prominent role in discussions.[0/]

1. Income-Consumption Model

In Tables XV and XVI, and Figures VI and VII, the results obtained from analysis of the income-consumption relations are presented. The data represents 15,140 farm and non-farm families classified by family type and by family income. During 1969, those Canadians who were sampled were found to consume 0.44 and 0.15 pounds per capita of chicken and turkey respectively, in an average week or 22.97 and 7.94 pounds annually.

The results set forth in Table XV and Figure VI pertain to the analysis of chicken meat. The relationship between income and consumption was found to be positive, as anticipated, and highly significant. The derived income elasticity coefficient from the relation is 0.1099 implying that a 10% increase in income is associated with a 1.1% increase in consumption.

In Figure VI the coefficients of the dummy variables representing deviations about a family size of two adults are plotted. According to the statistically insignificant coefficients consumption of chicken among family sizes of one, two, three, and four adults, and two adults/one child, cannot be distinguished, one from the other. Persons in these families had an apparent

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[0/] Since the basic data set used to derive the results was considered too voluminous to include in the thesis, a copy of these data has been placed on file in the Department of Agricultural Economics, University of Manitoba.

TABLE XV

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE INCOME-CONSUMPTION RELATIONSHIP FOR CHICKEN MEAT[a]

Independent Variables[b]	Units	Net Regression Coefficient	Student-t[c]	Elasticity
Constant		0.5435	11.38	
Average per capita income	$100/year	0.0018	3.56	0.1099
1A	-	-0.0362	0.36	-0.0064
1A/1C	-	-0.2783	2.78	-0.0409
2A/1C	-	-0.0638	0.67	-0.0113
2A/2C	-	-0.2233	2.34	-0.0394
2A/3C	-	-0.1375	1.44	-0.0243
2A/4C	-	-0.1679	1.75	-0.0296
2A/5+C	-	-0.3534	3.68	-0.0623
3A	-	-0.0847	0.89	-0.0149
3A/1C	-	-0.2052	2.15	-0.0362
3A/2+C	-	-0.1828	1.91	-0.0322
4A	-	-0.0241	0.25	-0.0043
other	-	-0.2174	2.27	-0.0384

S.E.E. = 0.1642 R^2 = 0.49 d.f. = 64
Mean = 0.4418 V.N. = 1.88

[a] The legend to be used for this and each of the tables to follow is:
S.E.E. - standard error of estimate;
R^2 - multiple coefficient of determination;
Mean - of the dependent variable;
V.N. - Von Neumann's ratio;
d.f. - degrees of freedom.

[b] The dependent variable was per capita weekly quantities purchased of chicken.

[c] The critical values of student-t at $\alpha = 0.10$ are 1.296 for the one-tailed test and 1.671 for the two-tailed test.

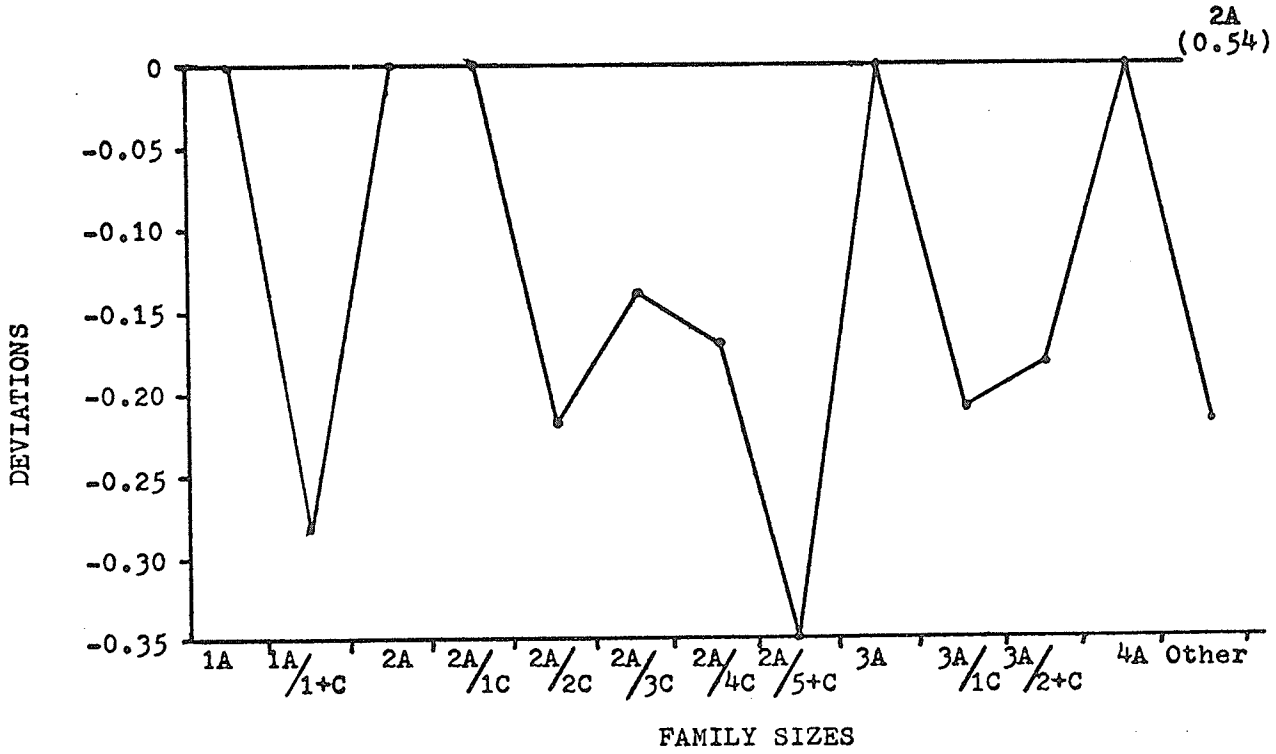

FIGURE VI

WEEKLY PER CAPITA CONSUMPTION OF CHICKEN BY FAMILY SIZES, REPRESENTED AS DEVIATIONS ABOUT A FAMILY SIZE OF TWO ADULTS

consumption of 28.25 pounds annually.[1/] All other family groups (on a per person basis) consumed less chicken than these family sizes. The distinguishing factor separating these two groups is the presence of children; and no allowance is made in the analysis to weight the lesser amounts of chicken that a child would consume relative to an adult portion. However it does appear very clear, and it is important to effective marketing of chicken, that additional children reduce the per capita consumption of chicken. On the basis of these results, one strategy for increasing the consumption of chicken meats is to offer the commodity in a manner that appeals to children, thus increasing their per capita consumption.

According to Table XIV a 'necessity' good is defined when family size elasticities fall within the range from zero to one. In Table XV the family size coefficients must be added to the constant term since they represent deviations about this value. These simple computations reveal family size elasticities of the magnitude that defines necessity goods. The results support the contention that chicken meat is a normal economic good.

The multiple coefficient of determination ($R^2 = 0.49$) is statistically significant and indicates that

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[1/] Actual per capita Canadian consumption in 1969 was 28.8 pounds.

in the grouped data, 49% of the variation in weekly per capita consumption of chicken has been explained by associated variations in income and family size. To further support the validity of this conceptual model, estimates of weekly per capita consumption made on the basis of the estimating equation will fall within ±37% of the mean value, 68% of the time. This relation does not appear to contain autocorrelation of the residuals.

The results set forth in Table XVI and Figure VII pertain to the analysis of turkey meat. These results must be viewed with caution since the calculated F-ratio, an assessment of the null hypothesis that $R^2 = 0$, proved to be insignificant. However, if it is accepted that the estimated income elasticity approaches zero, some credibility can be attached to the family size results. Apparent annual consumption per capita of turkey meat is 10.78 pounds[2/] among family sizes of two adults, two adults/two children, two adults/three children, two adults/five or more children, three adults, three adults/one child, and three adults/two or more children. With respect to chicken consumption, children were found to occupy a less prominent role in the family consumption pattern; in the case of turkey the results show that larger family sizes generally consume more turkey on a per capita basis. Considering the sizes in which turkeys

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[2/] Actual per capita consumption in 1969 was 9.9 pounds.

TABLE XVI

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE INCOME-CONSUMPTION RELATION FOR TURKEY MEAT[a]

Independent Variables	Units	Net Regression Coefficient	Student-t[b]	Elasticity
Constant		0.2073	7.16	
Average per capita income	$100/year	-0.0002	0.78	-0.0421
1A	-	-0.0694	1.14	-0.0354
1A/1C	-	-0.0842	1.39	-0.0358
2A/1C	-	-0.1062	1.84	-0.0542
2A/2C	-	-0.0165	0.29	-0.0084
2A/3C	-	-0.0274	0.47	-0.0140
2A/4C	-	-0.1361	2.34	-0.0695
2A/5+C	-	-0.0045	0.08	-0.0023
3A	-	-0.0176	0.31	-0.0090
3A/1C	-	-0.0203	0.35	-0.0104
3A/2+C	-	-0.0130	0.22	-0.0066
4A	-	-0.0728	1.26	-0.0372
other	-	-0.0659	1.13	-0.0336

S.E.E. = 0.0995 R^2 = 0.19 d.f. = 64
Mean = 0.1526 V.N. = 2.17

[a] The dependent variable was weekly per capita purchases of turkey.

[b] Critical values of student-t at $\alpha = 0.10$ are 1.296 for the one-tailed test and 1.671 for the two-tailed test.

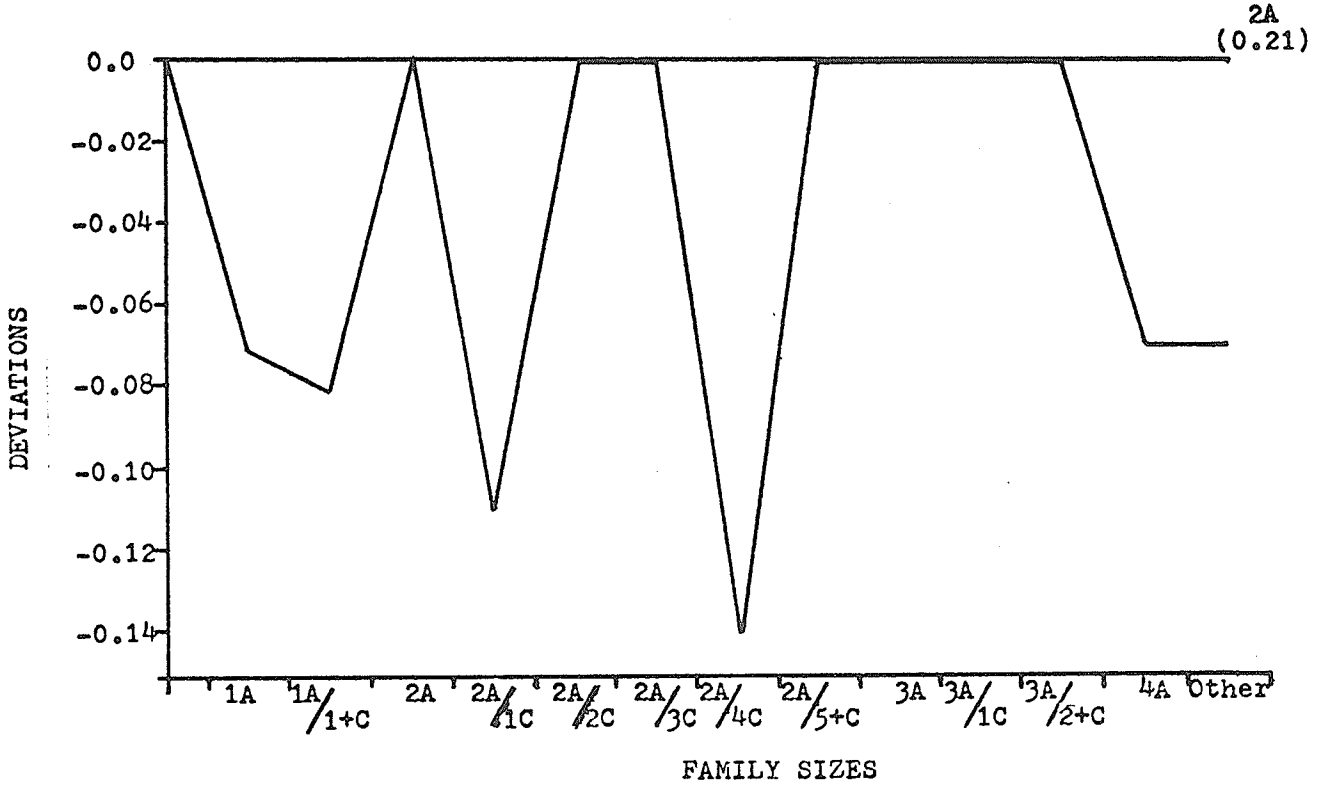

FIGURE VII

WEEKLY PER CAPITA CONSUMPTION OF TURKEY BY FAMILY SIZES, REPRESENTED AS DEVIATIONS ABOUT A FAMILY SIZE OF TWO ADULTS

are marketed and the consumer's distaste for 'leftovers', these results appear plausible.

2. Retail Price Model

Tables XVII and XVIII, and Figure VIII show the results obtained from analysis of the retail price relations. The data represent monthly observations of retail prices for broiler chicken and hen turkey covering the period 1963-1970. Average prices for that period were 41.30 and 43.18 cents per pound respectively.

The results presented in Table XVII can be used to evaluate the hypotheses that were posited in formulating the conceptual model for retail chicken prices. As explained in Chapter III, section A. 2, collinearity between per capita disposable income and the explanatory variables such as retail turkey prices ($r = -0.90$) made it advisable to analyse income effects separately to avoid problems of multicollinearity in the retail price relations. In this regard, monthly per capita consumption of chicken was adjusted to remove the effects of income which were derived in the previous section. The estimated relation (in logged form) between price and adjusted consumption was found to be negative and highly significant. The price flexibility coefficient was determined to be -0.2389 and price elasticity was computed to be -4.19. On average an increase of 10% in per capita chicken consumption is associated with a 2.4% decrease in retail chicken prices.

TABLE XVII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE RETAIL PRICE RELATION FOR BROILER CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		0.4759	1.17	
log adjusted PCQ rc	lbs/mo.	-0.2389	4.14	-0.2389
log P rb	¢/lb.	0.2779	2.91	0.2779
log P rp	¢/lb.	0.1694	2.83	0.1694
log USWP c	¢/ 100 lbs.	0.0222	0.26	0.0222
log P rt	¢/lb.	0.1885	1.72	0.1885
F	-	-0.0210	2.69	
M	-	-0.0100	1.30	
A	-	0.0021	0.29	
M	-	-0.0026	0.32	
J	-	-0.0021	0.26	
J	-	-0.0012	0.14	
A	-	0.0069	0.80	
S	-	-0.0024	0.30	
O	-	0.0019	0.26	
N	-	-0.0107	1.37	
D	-	-0.0354	4.50	
log trend	-	0.0072	0.46	

S.E.E. = 0.0142 R^2 = 0.83 d.f. = 78
Mean = 1.6160 V.N. = 1.40

[a] Critical values of student-t at α = 0.10 are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

Several commodities were hypothesized to be substitutes for chicken. In evaluating substitutability it was found that for 10% changes in retail prices of beef blade roast, pork shoulder roast and hen turkeys, retail broiler chicken prices changed by 2.8%, 1.7%, and 1.9% respectively. The effects of United States wholesale prices of chicken were not statistically significant implying that United States prices do not have an effect on monthly retail prices in Canada. Otherwise the results show varying degrees of substitutability between the red meats and turkey, and chicken meat with the strongest absolute impact resulting from beef prices.

The effects of changing consumer tastes and preferences were tested and found to be insignificant for the period 1963-1970. For shorter time periods, changes in monthly prices of broiler chicken can be seen in Figure VIII. Below January-level prices are noted during November, December, February and March. These results indicate that during the spring, summer, and fall months prices of broiler chicken are higher than during the winter months although the absolute magnitude of the net monthly variation is smaller than might be expected.

The multiple coefficient of determination ($R^2 = 0.83$) reveals that 83% of the variation in retail broiler chicken prices is associated with variations in the explanatory variables. In addition, 95% of the estimates of price derived from this relation are expected to fall within

±1.76 % of the mean price. The existence of positive autocorrelation, measured by Von Neumann's ratio, may have inflated the measurements of standard errors.

The results for the analysis of hen turkeys at the retail level are reported in Table XVIII and Figure VIII. For the period 1963-1970 Canadians consumed an average of 2.05 pounds per capita of hen turkey per year, and 8.57 pounds of turkey meat altogether. In the income-consumption analysis presented earlier the income effect for turkey meat consumption was found to be insignificant. Therefore the analysis of retail hen turkey prices was undertaken without an income variable. The relationship between per capita consumption and retail prices proved to be statistically insignificant for the period 1963-1970, and no elasticity value was computed. This situation denotes a failure of the model or of the data being analysed.

For the retail hen turkey price relation, the same commodities were hypothesized to be substitutes as for the chicken price relation. The results reveal that for increases of 10% in retail prices of beef blade roast and pork shoulder roast, retail hen turkey prices decreased 3.1% and increased 2.2% respectively. In the case of beef it is suggested that a complementary relation exists with turkey meat. Although conventional wisdom would support the contention that beef and turkey meats are substitutes, additional information from other relations to be presented in this analysis tends to refute the conventional hypothesis. Further discussion of these results takes place in Chapter V. Pork is shown to be a substitute for turkey as it was for chicken, and again the United States

TABLE XVIII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE RETAIL PRICE RELATION FOR HEN TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		50.8289	8.34	
PCQ	lbs/mo.	-1.1694	0.34	-0.0046
P_{rt}	¢/lb.	-0.2133	4.12	-0.3091
P_{rb}	¢/lb.	0.1643	4.84	0.2143
P_{rp}	¢/	0.0000	0.12	0.0042
USWP	100 lbs.			
P_{t}	¢/lb.	0.0649	0.62	0.0622
P_{rc}				
F	-	0.9068	1.40	
M	-	1.4391	2.08	
A	-	0.9539	1.36	
M	-	0.3722	0.53	
J	-	0.4863	0.69	
J	-	0.0945	0.13	
A	-	0.7642	1.04	
S	-	-0.8681	1.09	
O	-	-0.9194	0.76	
N	-	1.0624	1.47	
D	-	2.0855	0.65	
trend	-	-1.5016	11.94	

S.E.E. = 1.2757 R^2 = 0.93 d.f. = 78
Mean =43.1796 V.N. = 1.01

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

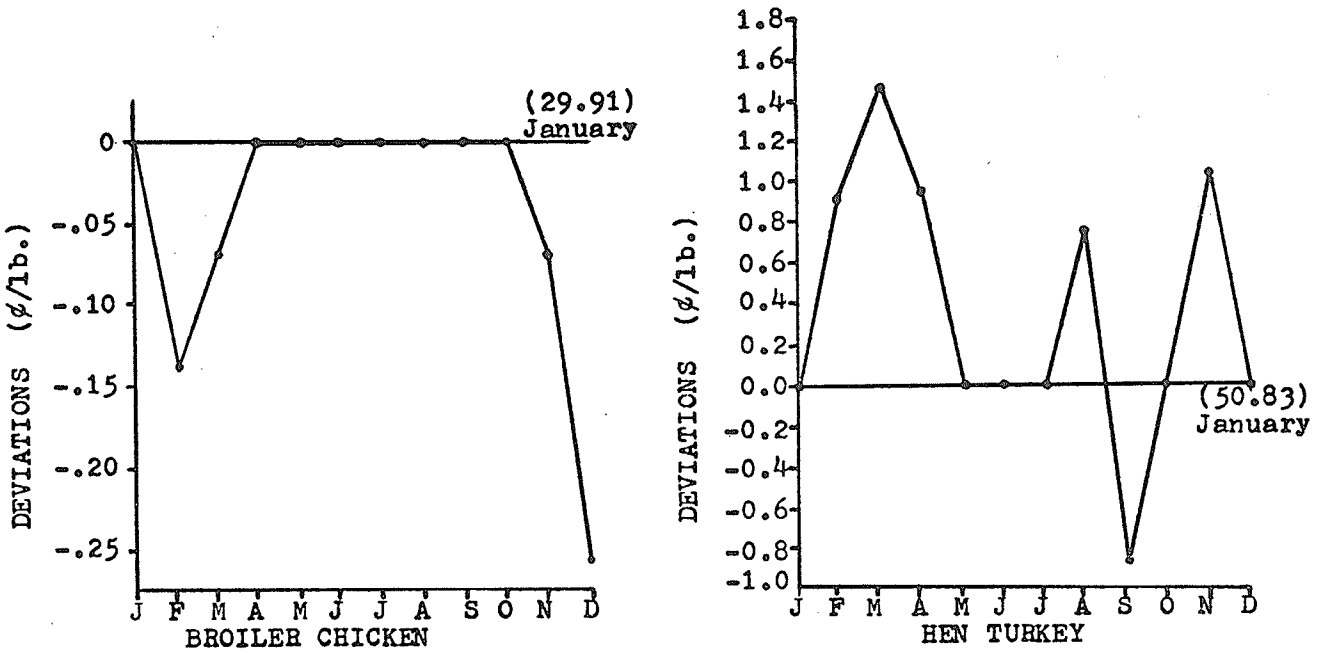

FIGURE VIII

NET SEASONAL RETAIL PRICES OF BROILER CHICKEN AND HEN TURKEY, REPRESENTED AS DEVIATIONS ABOUT JANUARY PRICES (1963-1970)

wholesale turkey price proved to be statistically insignificant. Retail broiler chicken price was included in the retail turkey price relation to evaluate the hypothesized substitutability of chicken for turkey; this hypothesis is rejected.

The effects of changes in consumer tastes and preferences over the time period being analysed were tested and found to be highly significant. These effects account for the estimated annual decrease in retail turkey prices of 1.50 ¢/lb. For shorter time periods changes in monthly prices of hen turkey represented as deviations about January levels can be seen in Figure VIII. Net prices are indicated to be about 1.50 ¢/lb. above January levels for the period in which Easter celebrations occur. Additional periods of higher prices occur immediately before Thanksgiving and Christmas with lower prices in September. The net seasonal pattern of retail hen turkey prices is both more pronounced and more important relative to broiler chicken prices.

In assessing the merit of the structural equation it is first necessary to acknowledge the likely presence of positive serial correlation, with resultant biases in significance levels. Variations in explanatory variables account for 93% of the variation in the dependent variable. Estimates derived from the equation will be within ±5.90% of the sample mean in 95 of 100 attempts.

3. Farm-Wholesale Model

1. Net import relation. The results obtained from

empirical analyses of the net import relations related to each category of poultry meat are presented in Tables XIX-XXIII. In Tables XIX and XX the results are presented for broiler and heavy chicken. For each of these categories the dependent variable was net imports of chicken meat since separate data for each category were not published. During the period 1963-1970 the monthly average net import of chicken meat was 86,005 pounds.

In Tables XXI, XXII, and XXIII the results are presented for broiler, hen and tom turkeys. For each of these categories the dependent variable was net imports of turkey meat since separate data on the individual categories could not be isolated from published data for total turkey. During the period 1963-1970 monthly average net import of turkey meat was 39,871 pounds.

In addition to the analysis of monthly dummy variables presented in Figure IX, three hypotheses were outlined for examination in the net import relations. The effects of farm production, inventory levels, and the Canadian-United States price differential were estimated.

In the case of broiler chickens the relationship between farm production and net imports was found to be insignificant. The relation with inventory was found to be negative, as anticipated, and highly significant with a 10% increase in inventory associated with an 11.3% decrease in net imports. The relationship with the price differential variable becomes significant if the tolerance of Type I

TABLE XIX

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE NET-IMPORT RELATION AS PROXIED FOR BROILER CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t [a]	Index of Responsiveness [b]
Constant		169.4964	1.35	
F	-	-74.4130	2.43	
M	-	-59.8473	2.05	
A	-	-41.5121	1.44	
M	-	-61.2494	1.97	
J	-	-55.7677	1.79	
J	-	-88.6670	2.69	
A	-	-95.4291	2.75	
S	-	-90.5947	2.75	
O	-	-53.4463	1.66	
N	-	-82.6778	2.67	
D	-	-17.8461	0.59	
Q	'000 lbs /mo.	0.0007	0.21	0.2563
TREND	-	11.5289	1.08	
INV 1	'000 lbs /mo.	- 0.0112	3.59	-1.1268
PDL 1	¢/lb.	- 5.7815	1.21	-0.0044
S.E.E. = 57,185.4		R^2 = 0.27		d.f. = 80
Mean = 86,004.9		V.N. = 1.07		

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

[b] The product of the net regression coefficient and the ratio of means of the independent and dependent variables.

errors is relaxed somewhat. However the anticipated effect is not obtained and a 10% increase in the difference between Canadian and United States wholesale prices is associated with a 0.04% decrease in net imports. The average size of the monthly price range is 0.07 ¢/lb. This apparent perverse behaviour on the part of importers must be interpreted in light of the inadequacy of the dependent variable. Due to the incorrect sign and low level of significance of this result it can probably be concluded that the price differential did not influence net imports as measured, implying that other factors are more important in determining the low level of net imports that are experienced. Changes in net imports associated with annual time periods were not statistically significant.

In the broiler chicken relation, the explanatory variables account for only 28% of the variation in net imports. Use of this structural equation for deriving estimates of net imports of broiler chicken will yield accuracy within ±66.49% of the mean, in 68% of the attempts, hardly a satisfactory predictive level but perhaps not too important given the absolute size of net imports.

In the case of heavy chickens the relationship between net imports and farm production was found to be negative and significant. A 10% increase in farm production of heavy chicken is associated with a 10.6% decrease in net imports. Inventory of heavy chicken is highly significant as well, with a 10% increase in storage stocks associated

TABLE XX

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE NET-IMPORT RELATION AS PROXIED FOR HEAVY CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Index of Responsiveness
Constant		332.6878	5.15	
F	-	- 78.0005	2.81	
M	-	- 66.3711	2.37	
A	-	- 52.0660	1.86	
M	-	- 70.4699	2.46	
J	-	- 69.4356	2.36	
J	-	- 98.9255	3.38	
A	-	-109.1203	3.71	
S	-	-104.3857	3.61	
O	-	- 49.9948	1.76	
N	-	- 68.0884	2.43	
D	-	- 42.9748	1.55	
Q_{f2}	'000 lbs /mo.	-0.0216	2.15	-1.0619
TREND	-	9.0925	2.08	
INV^2	'000 lbs /mo.	-0.0206	4.18	-1.1755
PDL_2	¢/lb.	-2.4873	1.10	-0.3219
S.E.E. = 54,592.3		R^2 = 0.33		d.f. = 80
Mean = 86,004.9		V.N. = 1.29		

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

with an 11.8% decrease in net imports. The price differential variable was not significant at an acceptible level and carried the wrong sign, as was the case with broiler chicken. The variable included in the relation to account for changes over time was significant, indicating that net imports of heavy chicken are rising over time at the rate of 9100 lbs/year.

In the heavy chicken relation, the explanatory variables account for 33% of the variation in net imports. Estimates of net imports of heavy chicken derived from this structural equation will, in 68% of attempts, fall within $\pm$63.48% of the mean value.

In the case of broiler turkeys the farm production and net import relationship is found to be significant with a 10% increase in farm production associated with a 14.1% decrease in net imports. Some caution must be exercised in attributing significance to the student-t values in equations such as this where the inflating effects of positive autocorrelation may be present. The relation between inventory and net imports is found to be positive, contrary to expectations, and significant. A 10% change in inventory level is associated with a 16.4% change in net imports. This evidence suggests that broiler turkeys are imported during periods of relatively high inventory, and exported (or lesser amounts imported) during periods of lower inventory. Since Canada is not self-sufficient in the production of turkey meats it is plausible that imports

TABLE XXI

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE NET-IMPORT RELATION AS PROXIED FOR BROILER TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a/]	Index of Responsiveness
Constant		55.8327	0.14	
F	-	17.6189	0.15	
M	-	225.8452	1.71	
A	-	188.6652	1.44	
M	-	297.4086	1.97	
J	-	492.2192	3.13	
J	-	309.7264	2.29	
A	-	44.3571	0.36	
S	-	- 7.9767	0.07	
O	-	231.8890	1.55	
N	-	-165.0587	1.25	
D	-	360.1166	2.10	
Q_{f3}	'000 lbs /mo.	- 0.1146	2.56	-14.0723
TREND	-	-70.0041	2.08	
INV_{3}	'000 lbs /mo.	0.1496	2.52	16.4406
PDL_{3}	¢/lb.	-29.9957	2.31	0.9630
S.E.E. = 237,362.5		R^2 = 0.30		d.f. = 80
Mean = 39,871.1		V.N. = 0.85		

[a/] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

occur during periods of inventory build-up immediately prior to Easter, Thanksgiving or Christmas celebrations. This contention finds additional support in the analysis of seasonal patterns in net imports presented in Figure IX. The effects of United States prices, depicted in the relationship between net imports and the price differential, was again significant and carried the correct sign relative to expectations. In this case a 10% change in the price differential is associated with a 9.6% change in net imports. The average magnitude of the price difference is -1.28 ¢/lb., implying that the Canadian price has remained, on average, just below the landed United States price. Over the time period 1963-1970 the results reveal that net imports of broiler turkeys are decreasing.

The explanatory variables in the broiler turkey relation account for 30% of the variation in net imports. The magnitude of the standard error of estimate indicates that this relation would provide a very poor prediction of net imports.

In the case of hen turkey the relationship between net imports and farm production, inventory, price differential, and trend are found to be insignificant. On the basis of these results further analysis of the net import relation for hen turkeys was abandoned.

In the case of tom turkey the relationship between farm production and net imports is found to be insignificant. The effects of inventory are highly significant and carry the

TABLE XXII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE NET-IMPORT RELATION AS PROXIED FOR HEN TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Index of Responsiveness
Constant		268.8851	0.66	
F	-	6.6751	0.05	
M	-	28.4485	0.22	
A	-	- 36.0571	0.25	
M	-	- 59.4341	0.37	
J	-	89.7239	0.53	
J	-	- 9.1430	0.05	
A	-	-174.6383	0.59	
S	-	- 75.8318	0.20	
O	-	- 15.3273	0.04	
N	-	- 57.0608	0.12	
D	-	-130.6816	0.57	
Q_{f4}	'000 lbs /mo.	0.0381	0.80	3.3368
TREND	-	- 10.6406	0.46	
INV_4	'000 lbs /mo.	- 0.0296	0.88	-7.0025
PDL_4	¢/lb.	0.7627	0.07	0.0285
S.E.E. = 248,344.2		R^2 = 0.23		d.f. = 80
Mean = 39,871.1		V.N. = 0.69		

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

TABLE XXIII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE NET-IMPORT RELATION AS PROXIED FOR TOM TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a/]	Index of Responsiveness
Constant		284.5558	1.57	
F	-	- 85.5903	0.77	
M	-	- 72.1607	0.64	
A	-	-120.9513	1.07	
M	-	-176.8762	1.53	
J	-	- 23.8949	0.20	
J	-	- 48.9849	0.41	
A	-	- 74.7563	0.46	
S	-	146.6492	0.60	
O	-	380.9149	1.21	
N	-	281.5085	1.11	
D	-	122.1914	0.81	
Q_{f5}	'000 lbs /mo.	-0.0094	0.49	-1.4493
TREND	-	-4.9480	0.43	
INV_5	'000 lbs /mo.	-0.0182	3.71	-7.1599
PDL_5	¢/lb.	31.8980	3.31	2.3452
S.E.E. = 214,299.4		R^2 = 0.43		d.f. = 80
Mean = 39,871.1		V.N. = 1.06		

[a/] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

anticipated negative sign. A 10% increase in storage stocks is associated with a 71.6% decrease in net imports. The anticipated positive relationship between the price differential and net imports is obtained at a high level of significance. The magnitude of the monthly price differential averages 2.93 ¢/lb. and a 10% increase in this magnitude is associated with a 23.5% increase in net imports. During 1963-1970 the results show that net imports are not significantly affected by factors which change systematically over time.

In the tom turkey relation the explanatory variables account for 43% of the variation in net imports. Nevertheless, estimates of net imports derived from this structural equation will not lie near the mean in most cases.

In Figure IX net imports of poultry meats, excluding hen turkeys, are depicted as deviations from January levels.[3/] For broiler and roasting chickens net imports are lowest during the month of August, with the months of July and September in close proximity. The similarity in the graphic representations for the chicken categories is partly related to the use of the same dependent variable in both behavioural relations. For broiler chickens the lower net imports during the summer months may be a response to higher

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3/ In plotting the net seasonal pattern, regression coefficients that were not statistically significant for at least the 25% probability level were recorded as zero or equal to the January level.

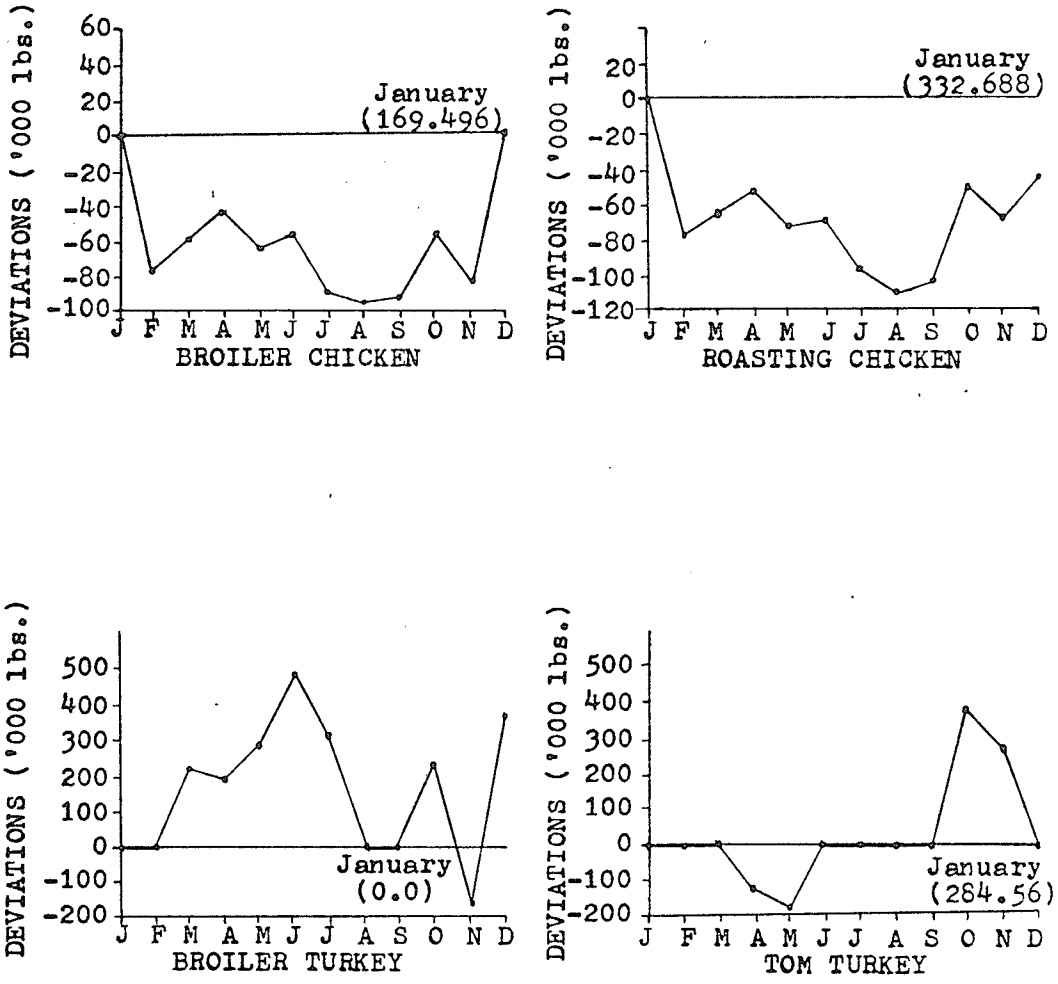

FIGURE IX

NET SEASONAL IMPORTS OF POULTRY PRODUCTS
REPRESENTED AS DEVIATIONS ABOUT
JANUARY LEVELS (1963-1970)

farm production of this commodity as depicted in Figure XIII.

For broiler and tom turkeys, the deviations presented graphically in Figure IX bear slight resemblance to each other even though the same dependent variable entered each relation. Broiler turkey net imports, derived from turkey net imports, could not be distinguished from January levels for the month of February, August and September. Highs were associated with the months of June and December while a low occurred in November. Inspection of Figure X, showing deviations in inventory about January levels, corroborates the net import findings for broiler turkeys to some extent. Lows in inventory levels of broiler turkey are found to be associated with months noted for relatively higher net imports. The significance of the inventory variable in explaining net imports was examined in Table XXI. Deviations about January levels of tom turkey net imports are not readily explainable from Figure IX. Through most months of the year net imports remain at January levels, reaching a higher level in October presumably in response to Thanksgiving demand.

ii. Inventory relations. The results obtained from empirical analyses of the inventory relations for each category of poultry meat are presented in Tables XXIV-XXVIII. In addition to the analyses of monthly dummy variables presented in Figure X, seven hypotheses were

outlined for examination in the inventory relation. The effects of farm production and domestic disappearance were estimated, as well as the effects of several price variables including the retail prices of beef, pork and poultry, and the farm to wholesale price spread. Finally consideration was made of factors changing systematically over time.

End-of-month storage stocks of broiler chickens averaged 8,685,798 pounds for the period 1963-1970. The relationship between inventory and farm production of broilers is found to be positive, in agreement with expectations, and statistically significant. A 10% change in farm production accounts for a 1.7% change in inventory levels. Also statistically significant is the negative relationship found to exist between stocks of broiler chickens and retail prices of pork. A 10% increase in pork prices is associated with a 10.9% decrease in inventory implying that as pork prices rise chicken sales increase. The other retail prices included in this relation were revealed to be insignificant, as was the hypothesized relation between inventory levels of broiler chicken and the farm to wholesale price spread. Over the study period no annual variations in stocks of broiler chickens were detected. It was impossible to include in the inventory relation for broiler chickens a measure of the effects of domestic disappearance without incorporating an undesirable degree of multicollinearity between farm production and

TABLE XXIV

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE INVENTORY RELATION FOR BROILER CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Index of Responsiveness
Constant		7712.3184	0.62	
F	-	1106.3296	0.95	
M	-	- 9.8716	0.01	
A	-	- 483.7473	0.43	
M	-	-2688.2098	2.20	
J	-	-2730.4859	2.23	
J	-	-3294.4719	2.52	
A	-	-3381.7771	2.45	
S	-	-3149.0603	2.39	
O	-	-1674.1495	1.35	
N	-	-1319.1332	1.10	
D	-	2659.6895	2.42	
Q	'000 lbs /mo.	0.4485	3.50	1.7044
P rt	¢/lb.	- 57.6255	0.30	-0.2865
P rb	¢/lb.	- 68.2732	0.74	-0.4918
P rp	¢/lb.	-168.7331	2.61	-1.0944
TREND	-	- 26.7881	0.05	
MM 1	¢/lb.	290.0034	1.04	0.4377
S.E.E. = 2,152,234.8		R^2 = 0.78		d.f. = 78
Mean = 8,685,798.0		V.N. = 0.25		

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

domestic disappearance ($r_{Qf,Qr} = 0.992$). In this case the domestic disappearance variable was removed.

In applying this structural equation to deriving estimates of broiler chicken inventory, the results produced will lie within ±24.78% of the mean in two-thirds of the attempts. In the dependent variable 78% of the variationis accounted for by variations among the explanatory variables. The explosive effects of positive serial correlation evident in this equation will discourage its use as a predictive model. It is likely that measures of standard errors of the regression coefficients are downward biased, imparting a spurious credibility to the student-t tests.

End-of-month storage stocks of heavy chickens averaged 4,898,565 pounds for the period 1963-1970, while farm production and domestic disappearance averaged 4,224,672 and 4,260,747 pounds respectively. The relationship between inventory and farm production, shown in Table XXV, is highly significant and shows that a 10% change in farm production is associated with an 8.8% change in inventory. Changes in domestic disappearance are also found to effect significant responses in inventory, with a 10% increase in consumption associated with a -6.0% decrease in stocks. Of the retail prices included in the inventory relation, significant effects between turkey and beef prices and stocks of roasting chickens are found. A 10% increase in retail hen turkey prices is associated with

TABLE XXV

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE INVENTORY RELATION FOR HEAVY CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a/]	Index of Responsiveness
Constant		13983.4469	1.86	
F	-	804.8720	1.20	
M	-	1044.6725	1.45	
A	-	639.8544	0.90	
M	-	439.9039	0.61	
J	-	232.0508	0.32	
J	-	-164.9167	0.24	
A	-	-230.5722	0.32	
S	-	-462.0767	0.66	
O	-	-550.7148	0.79	
N	-	536.5839	0.75	
D	-	806.5441	0.91	
Q_{f2}	'000 lbs /mo.	1.0164	4.00	0.8766
P_{rt}	¢/lb.	-151.4580	1.28	-1.3351
P_{rb}	¢/lb.	112.1304	1.94	1.4021
P_{rp}	¢/lb.	- 18.6280	0.48	-0.2142
TREND	-	-237.0412	1.12	
MM_2	¢/lb.	-459.7678	4.25	-1.8498
Q_{r2}	'000 lbs /mo.	- 0.6888	1.48	-0.5992

S.E.E. = 1,287,137.8 R^2 = 0.59 d.f. = 77
Mean = 4,898,564.7 V.N. = 0.40

[a/] Critical values of student-t at α = 0.10 are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

a 13.4% decrease in heavy chicken stocks, lending credence to the hypothesis that hen turkey and heavy chicken meats are substitutes for each other. In the case of beef, however, the results indicate a significant positive relation. A 10% change in retail beef prices is associated with a 14.3% change in stocks of heavy chickens. Once again evidence supports the contention that beef bears a complementary relationship with poultry meat. The farm to wholesale price spread is found to carry a negative sign, as anticipated, and a highly significant relation to heavy chicken inventory. An increase of 10% in the difference between farm and wholesale prices accounts for an 18.5% decrease in storage implying that wholesalers are arbitraging on inventory. Relative to systematic factors associated with time, during the period analysed, inventory levels of roasters are found to vary insignificantly.

The small magnitude of the Von Neumann ratio shown in Table XXV indicates the likely presence of positive serial correlation. This being the case, the results of statistical tests must be interpreted cautiously. In the inventory relation for roasters, explanatory variables account for 59% of the variation in the dependent variable. In addition, estimates derived from this equation will lie within ±26.27% of the mean in 68% of attempts.

In Table XXVI the results are presented for the analysis of the broiler turkey inventory relation. For the period covered in the sample, average inventory levels of

TABLE XXVI

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE INVENTORY RELATION FOR BROILER TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a/]	Index of Responsiveness
Constant		-9088.6997	1.91	
F	-	- 306.3264	0.59	
M	-	-1212.0361	1.85	
A	-	-1093.9140	1.68	
M	-	-1666.5936	2.54	
J	-	-1823.0482	2.94	
J	-	- 954.8912	1.79	
A	-	- 535.5277	1.07	
S	-	- 185.7532	0.35	
O	-	-1939.1150	2.35	
N	-	-1111.0858	2.16	
D	-	-2947.8487	2.98	
Q_{f3}	'000 lbs /mo.	0.5342	3.22	0.5967
P_{rt}	¢/lb.	137.4542	1.86	1.3544
P_{rb}	¢/lb.	39.4470	1.13	0.5632
P_{rp}	¢/lb.	-42.5213	1.61	-0.5466
TREND	-	501.1290	3.00	
MM_3	¢/lb.	218.5106	2.14	0.7081
Q_{r3}	'000 lbs /mo.	0.1298	0.58	0.1456

S.E.E. = 819,263.7 R^2 = 0.81 d.f. = 77
Mean = 4,382,263.1 V.N. = 1.27

[a/] Critical values of student-t at α = 0.10 are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

broiler turkeys were 4,382,263 pounds. The relation with farm production is found to be significant, with a 10% change in farm production accounting for a 6.0% change in stocks. The relation with domestic disappearance is found to be insignificant. Retail prices of hen turkey and pork contributed to explaining variations in broiler turkey stocks with 10% changes in these variables associated with 13.5% and -5.5% changes in inventory levels respectively. A complementary relationship between hen and broiler turkey meats is suggested but must be interpreted cautiously. For periods within the year broiler and hen turkey inventories move in similar patterns (Figure X) that may be unrelated to price variations. The farm to wholesale price spread is found to be significant with 10% changes in its magnitude accounting for 7.1% changes in broiler turkey stocks. There is a significant net positive trend in storage stocks of broiler turkeys of 501,129 lbs./year.

In the inventory relation for broiler turkey a lesser likelihood of missing variables exists relative to earlier inventory relations due to the greater magnitude of the Von Neumann ratio. With 81% of variation in inventory levels being accounted for, estimates derived from this equation are seen to fall within $\pm$37.38% of the mean value, 95% of the time.

In Table XXVII the results are presented for the analysis of the inventory relation for hen turkey. Average inventory levels of hen turkey were 9,432,911 pounds

TABLE XXVII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE INVENTORY RELATION FOR HEN TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a/]	Index of Responsiveness
Constant		- 3242.2822	0.44	
F	-	- 379.7601	0.59	
M	-	- 2068.8633	2.59	
A	-	- 3329.6083	4.08	
M	-	- 3838.1156	4.88	
J	-	- 4096.7126	5.18	
J	-	- 3795.8938	3.99	
A	-	- 1879.5484	1.24	
S	-	2171.9987	1.22	
O	-	2094.5053	0.92	
N	-	9395.3843	7.02	
D	-	-12146.9373	2.19	
Q_{f4}	'000 lbs /mo.	0.6335	2.73	0.2342
P_{rc}	¢/lb.	74.8157	0.64	0.3425
P_{rb}	¢/lb.	96.7134	1.76	0.6414
P_{rp}	¢/lb.	-41.6834	1.01	-0.2489
TREND	-	607.8374	2.57	
MM_4	¢/lb.	36.9677	0.21	0.0577
Q_{r4}	'000 lbs /mo.	0.4953	1.62	0.1847

S.E.E. = 1,227,571.3 R^2 = 0.96 d.f. = 77
Mean = 9,432,910.9 V.N. = 0.75

[a/] Critical values of student-t at α = 0.10 are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

monthly for the period studied. Monthly farm production and domestic disappearance averaged 3,487,747 and 3,518,041 pounds respectively. The effects of each of these variables are estimated and significant estimates of the coefficients are derived. The sign associated with farm production is positive as expected, and that of domestic disappearance is positive, contrary to expectations. In this regard a 2.3% change in farm production is associated with a 10% increase in inventory; while a 1.9% change in domestic disappearance accounts for the same inventory change. The unanticipated positive relationship between inventory and domestic disappearance may be plausible since inventory stocks are building up at a rate in excess of consumption increases, during parts of the year, in anticipation of large decumulations at Thanksgiving and Christmas. The effects of retail prices of beef, pork and turkey are presented with significance attained for beef only. Multicollinearity of retail chicken prices and the farm to wholesale price spread ($r_{Pro,MM4} = 0.82$) required the substitution of retail turkey prices for those of chicken. This substitution is less than adequate but no other retail price series was available. The relationship found between beef prices and hen turkey inventory carried a positive sign, with an inventory change of 6.4% associated with a 10% change in the retail price of beef blade roast. The likelihood of a complementary relationship existing between beef and poultry meats is

once again suggested in this equation. The effects of the farm to wholesale price spread proved to be insignificant. Through the period 1963-1970 a significant positive net trend in hen turkey inventory in the order of 607,837 lbs./ year was obtained.

The possibility of a missing variable or variables seems likely in the hen turkey relation on the basis of the Von Neumann ratio. In this equation, however, 96% of variation in hen turkey stocks have been accounted for and estimates can be expected to lie within ±26.02% of the mean in most attempts. In general, this relation is not satisfactory for explaining or predicting hen turkey inventory.

The results of analysis of tom turkey inventory are presented in Table XXVIII. On a monthly basis inventory of tom turkeys averaged 15,691,272 pounds with farm production and domestic disappearance much less at 6,178,102 and 6,212,879 pounds respectively. A significant relationship is found between farm production and tom turkey inventory with a 10% increase in production associated with a 5.7% increase in stocks. In the case of domestic disappearance the estimated relationship proved insignificant. This result was not entirely unexpected, since inventories build up to three distinct withdrawal periods each year. The effects of retail prices on inventory of tom turkeys were estimated but significant results are obtained only for pork. A 10% change in pork prices is reflected in a 23.7%

TABLE XXVIII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE INVENTORY RELATION FOR TOM TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a/]	Index of Responsiveness
Constant		7326.8947	0.24	
F	-	404.1680	0.15	
M	-	- 1392.8746	0.52	
A	-	- 3441.2626	1.30	
M	-	- 5047.0266	1.81	
J	-	- 8310.4325	3.17	
J	-	-10813.0688	3.98	
A	-	-14333.2797	3.57	
S	-	-15181.1657	2.40	
O	-	-13004.5736	1.48	
N	-	3474.7907	0.55	
D	-	-10692.4395	0.82	
Q_{f5}	'000 lbs /mo.	1.4336	3.32	0.5645
P_{rt}	¢/lb.	-509.0113	1.06	-1.4007
P_{rb}	¢/lb.	-166.1607	0.68	-0.6625
P_{rp}	¢/lb.	660.4335	4.20	2.3711
TREND	-	-315.1549	0.36	
MM_5	¢/lb.	108.2583	0.17	0.1025
Q_{r5}	'000 lbs /mo.	0.1633	0.34	0.0646

S.E.E. = 5,029,540.4 R^2 = 0.81 d.f. = 77
Mean = 15,691,212.4 V.N. = 0.61

[a/] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

change in inventory level. The unexpected positive relationship brings to light the possibility that pork and turkey meats are complementary goods although that appears to be implausible from other results obtained in this study. Anticipation of effects on the inventory of tom turkeys arising from the farm to wholesale price spread and annual trend are revealed to have no statistical basis.

As with previous inventory relations, a high likelihood of positive serial correlation exists in the case of tom turkey. With 81% of the variation in stocks accounted for, estimates of inventory derived from this equation will lie within ±32.05% of the mean in two out of three attempts.

In Figure X inventory levels of poultry meats are represented as deviations from January levels. For the broiler chicken category stocks are lowest during July, August and September and highest in December with a range of almost six million pounds. This pattern concurs with previous information supporting stronger demands for chicken during summer relative to winter months. For roasting chickens the only months distinguishable from January are February and March. An explanation for these results is likely related to the accumulation of product to satisfy Easter demands. In the case of broiler turkey inventories, a definite seasonal pattern is evident. Inventory levels fall to June with a slight increase around the Easter season, rise to September in anticipation

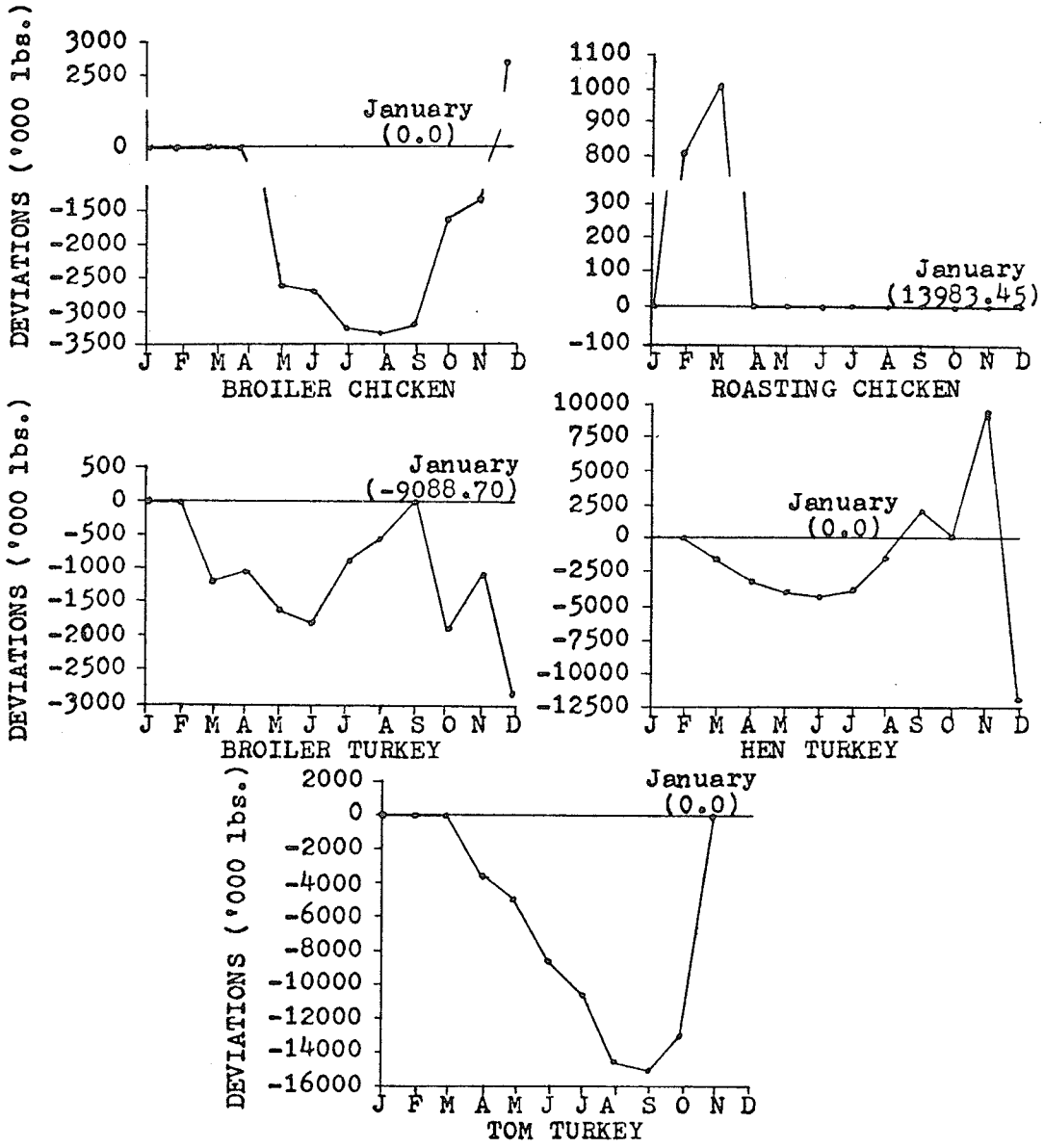

FIGURE X

NET SEASONAL POULTRY INVENTORY REPRESENTED
AS DEVIATIONS ABOUT JANUARY LEVELS
(1963-1970)

of Thanksgiving, and begin again to fall to a Christmas low, with a recovery in November. The pattern for broiler turkey inventory is repeated in more moderate form for hen turkeys. Missing from the analogy is the build-up in inventory prior to Easter. The inventory pattern by months for tom turkeys resembles the other classes of turkey in a progressive decline to early summer, but lowest inventory levels occur prior to Thanksgiving. The rapid return to January levels accomplished during October-November may represent an inventory build-up for December demands, but this negates the contention that inventory levels accrue during the year in preparation for large decumulations during months of strong traditional demand.

iii. Wholesale price relations. The results obtained from empirical analysis of the wholesale price relations for each category of poultry meat are presented in Tables XXIX-XXXIII. In addition to the analysis of monthly effects presented in Figure XI, eight hypotheses were outlined for examination in the wholesale price relation. Initially the study is concerned with examining the effects of several measures of deflated price, including retail prices of poultry, beef and pork, and wholesale prices of poultry meat substitutes. Per capita domestic disappearance and inventory level effects on wholesale prices are evaluated next, and finally factors associated with annual time periods are estimated.

In Table XXIX results are presented from analysis of the broiler chicken wholesale price relation. At the wholesale level, broiler chicken prices averaged 30.4 ¢/lb. during 1963-1970. The relationship between wholesale and retail prices of broiler chicken is highly significant with a 10% change in retail price associated with a 9.7% change in wholesale price. This evidence suggests that on average, the percentage component of the margin between wholesalers and retailers is constant. As outlined in Chapter III, A., 5, the derived effect, on the wholesale to retail price spread, of a 1 ¢/lb. increase in retail broiler chicken prices will be to increase the magnitude of the margin by 0.29 ¢/lb. (i.e. $1-\delta P_w/\delta P_{rc}$). In assessing the potential substitutability of other meats for broiler chicken, beef, pork, hen turkey, and broiler turkey were considered. Prices were included for each variable except broiler turkey where degrees of multicollinearity of 0.90 and -0.82 were obtained with wholesale price of hen turkey and per capita disappearance of broiler chicken respectively. In order to circumvent this problem per capita disappearance of broiler turkey was substituted for its wholesale price. In each of these cases the hypothesis of substitutability was rejected due to lack of statistical evidence. The relationship between per capita disappearance and wholesale price of broilers carries a negative sign and is significant. Associated with a 10% change in per capita disappearance is a 5.5% change in wholesale price. The

TABLE XXIX

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE WHOLESALE PRICE RELATION FOR BROILER CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		4.9543	0.41	
F	-	- 0.5925	0.65	
M	-	0.5641	0.51	
A	-	0.6768	0.64	
M	-	3.4112	2.41	
J	-	3.4673	2.59	
J	-	4.7042	3.68	
A	-	4.3613	3.41	
S	-	3.9202	3.19	
O	-	1.4109	0.89	
N	-	2.1249	1.72	
D	-	- 0.8189	0.51	
P_{rc}	¢/lb.	0.7100	5.66	0.9674
TREND	-	1.4764	3.49	
P_{rb}	¢/lb.	- 0.0578	0.90	-0.1190
P_{rp}	¢/lb.	0.0677	1.10	0.1255
P_{w4}	¢/lb.	0.0970	0.48	0.1186
PCQ_{r3}	lbs/mo.	3.6789	0.55	0.0290
PCQ_{r1}	lbs/mo.	-10.3491	3.21	-0.5541
INV_{1}	'0,000 lbs /mo.	- 0.0004	0.43	-0.0127

S.E.E. = 1.3812 R^2 0.79 d.f. = 76
Mean = 30.3885 V.N. = 1.19

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

effects of broiler chicken inventory on wholesale price are found to be insignificant. Systematic changes over the study period show that wholesale prices are increasing significantly at the rate of 1.5 ¢/lb./year on average.

The explanatory variables in the broiler chicken relation account for 79% of the variation in wholesale prices. If this structural equation was employed in deriving estimates of wholesale prices of broiler chicken the results show that 95% of the time derived estimates would lie within ±9.10% of the mean.

In the case of heavy chickens, wholesale prices averaged 40.01 ¢/lb. during 1963-1970. Evidence in support of a nearly proportionate (i.e. 1 to 1) marketing margin on average is found in Table XXX. A 10% change in retail broiler chicken price accounts for an 8.8% change in wholesale price of heavy chicken. An increase of 1 ¢/lb. in the proxied retail price of heavy chicken is found to be associated with a 0.15 ¢/lb. increase in the wholesale to retail price spread. In assessing the effects of other poultry categories or red meats for potential substitutability with roasters only one category achieved statistical significance. A 2.7% change in the wholesale price of roasters is found to be the average response to a 10% change in the wholesale price of broiler turkeys. Correlation between wholesale prices of hen and broiler turkeys required the former price to be replaced by the per capita disappearance of hen turkeys. The postulated

TABLE XXX

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE WHOLESALE PRICE RELATION FOR HEAVY CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a/]	Price Flexibility
Constant		-3.2145	0.27	
F	-	1.3237	1.46	
M	-	1.2966	1.16	
A	-	1.0541	0.89	
M	-	2.5380	2.24	
J	-	1.8608	1.62	
J	-	1.7333	1.43	
A	-	0.7609	0.59	
S	-	0.7857	0.51	
O	-	-0.9667	0.33	
N	-	1.4996	1.25	
D	-	-2.7900	0.33	
P_{rc}	¢/lb.	0.8484	5.28	0.8780
TREND	-	0.1290	0.45	
P_{rb}	¢/lb.	-0.0695	0.89	-0.1087
P_{rp}	¢/lb.	0.0616	1.14	0.0868
PCQ_{r4}	lbs/mo.	6.0005	0.63	0.0256
P_{w3}	¢/lb.	0.3035	1.50	0.2677
PCQ_{r2}	lbs/mo.	-9.1671	0.66	-0.0475
INV_{2}	'000 lbs /mo.	-0.0004	2.49	-0.0549
S.E.E. = 1.7597		R^2 = 0.86		d.f. = 76
Mean = 40.0102		V.N. = 1.06		

[a/] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

relation between wholesale prices and per capita disappearance of heavy chickens is revealed to be insignificant, implying that the same price was attained irrespective of the volume sold. In the relationship between inventory and wholesale price a significant negative effect is obtained. Associated with a 10% increase in roaster stocks is a 0.6% decrease in wholesale price. Over the period analysed no systematic net variations in wholesale prices of heavy chickens are detected.

Notwithstanding the likely presence of positive serial correlation, the conceptual structure outlined has accounted for 86% of the variation in wholesale prices of heavy chicken. Estimates derived from this equation lie within ±8.80% of the mean, 95% of the time.

In the case of broiler turkeys the average monthly wholesale price through the period 1963-1970 was 35.29 ¢/lb. To determine the type of market margin separating wholesale and retail market levels, the retail price of hen turkeys is included as a proxy of retail broiler turkey price in the wholesale price relation for broiler turkeys. The estimated effect is significant, showing that a 10% increase in retail price is associated with a 3.5% increase in wholesale price. Apparently the margin is composed of an absolute component in addition to the constant proportion, but this might not have resulted if a retail price series for broiler turkeys had been available. The derived effect on the wholesale to retail price spread

TABLE XXXI

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE WHOLESALE PRICE RELATION FOR BROILER TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		5.8791	0.72	
F	-	0.4390	0.55	
M	-	0.5528	0.50	
A	-	-0.3109	0.28	
M	-	0.2212	0.18	
J	-	-0.0179	0.02	
J	-	-1.3620	1.40	
A	-	-1.1019	1.16	
S	-	0.2679	0.26	
O	-	0.3627	0.17	
N	-	2.0202	2.38	
D	-	-7.7728	1.24	
P_{rt}	¢/lb.	0.2868	2.42	0.3510
TREND	-	0.2319	0.72	
P_{rb}	¢/lb.	0.0469	0.85	0.0832
P_{rp}	¢/lb.	0.0621	1.55	0.0992
PCQ_{r4}	lbs/mo.	12.9495	1.75	0.0627
P_{w1}	¢/lb.	0.4636	4.03	0.3992
PCQ_{r3}	lbs/mo.	-18.4362	2.66	-0.1250
INV_{3}	'000 lbs /mo.	- 0.0004	1.37	-0.0506

S.E.E. = 1.2632 R^2 = 0.89 d.f. = 76
Mean = 35.2877 V.N. = 0.96

[a] Critical values of student-t at α = 0.10 are 1.293 for the one-tailed test and 1.664 for the two-tailed test.

associated with a 1 ¢/lb. increase in retail broiler turkey prices is computed to be an increase of 0.71 ¢/lb. in the magnitude of the margin. The assessment of other commodities as possible substitutes for broiler turkey met with considerable success, the only relation found insignificant was with the retail price of beef. Consequently, associated with a 10% change in retail pork price is a 1.0% change in broiler turkey prices; associated with a 10% change in wholesale broiler chicken prices is a highly significant 4.0% change in broiler turkey prices. The relationship between per capita domestic disappearance of hen turkey and broiler turkey wholesale price is significant but reveals an unexpected effect in being positive. A 10% change in per capita domestic disappearance of hens is associated with a 0.6% change in the wholesale price of broiler turkeys. The explanation for this small but incorrect change is suggested to be related to the substitution of a quantity for a price variable. Significant results carrying the signs expected are revealed in the relationships between inventory and per capita domestic disappearance of broiler turkeys with the wholesale price of broilers. 10% increases in inventory levels and in per capita domestic disappearance of broiler turkeys are associated with 0.5% and 1.3% decreases in wholesale broiler turkey prices. No statistically significant trend effects were revealed in wholesale prices of broiler turkeys.

The explanatory variables in the structural equation denoting wholesale prices of broiler turkey account for 89% of the variation in the dependent variable. Estimates derived from this relation will in 95% of cases lie within ±7.18% of the mean. The relation appears to contain the problem of positive serial correlation.

In the case of hen turkeys the average wholesale price through the period 1963-1970 was 37.14 ¢/lb. The wholesale price is not significantly, in a statistical sense, related to the retail hen turkey price. As a consequence the evidence is that the wholesale to retail margin for this poultry meat category is not of the constant percentage type. The derived effect on the margin associated with a 1 ¢/lb. increase in retail hen turkey prices is to increase the price spread by the same amount, since the coefficient on the retail price variable is not significantly different from zero. For the other price variables it can be seen that beef and broiler chicken meats have no statistically measurable effect on the wholesale price of hens, while pork and broiler turkey prices do have a significant effect. The negative beef price coefficient is evidence of a complementary relationship but at a marginal level of significance. Increases in the order of 1.7% and 4.3% in the hen price are associated with 10% increases in retail pork and wholesale broiler turkey prices respectively. In the relation with per capita consumption of hens the hypothesis of a negative influence has to be

TABLE XXXII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE WHOLESALE PRICE RELATION FOR HEN TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t [a]	Price Flexibility
Constant		25.9585	2.11	
F	-	- 0.3905	0.46	
M	-	- 1.3542	1.14	
A	-	- 2.0103	1.45	
M	-	- 2.6277	1.97	
J	-	- 2.8233	2.08	
J	-	- 2.2066	1.75	
A	-	0.3558	0.29	
S	-	3.1709	1.56	
O	-	4.3858	1.45	
N	-	7.5246	2.35	
D	-	- 1.6436	0.20	
P_{rt}	¢/lb.	- 0.0600	0.41	-0.0697
TREND	-	- 0.4378	1.28	
P_{rb}	¢/lb.	- 0.0811	1.12	-0.1365
P_{rp}	¢/lb,	0.1102	2.08	0.1672
P_{w3}	¢/lb.	0.4555	2.27	0.4328
P_{w1}	¢/lb.	0.0806	0.59	0.0660
PCQ_{r4}	lbs/mo.	1.8519	0.21	0.0085
INV_{4}	'000 lbs /mo.	- 0.0005	2.00	-0.1195

S.E.E. = 1.6117 R^2 = 0.85 d.f. = 76
Mean = 37.1365 V.N. = 0.79

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

rejected due to lack of statistical significance implying that the same price was attained irrespective of the volume sold. The relationship with hen turkey inventory proved to be significant and negative as anticipated. A 10% increase in inventory is associated with a 1.2% decrease in wholesale price. If the tolerance of Type I errors is relaxed slightly, the relationship perceived between wholesale prices and trends is revealed to be a significant and negative 0.44 ¢/lb./year.

The hen turkey wholesale price relationship is apparently affected by serial correlation . One of the items to be discussed at the end of this chapter will be the pervasive "missing-variable problem". Aside from this aspect, the proportion of variation in wholesale prices accounted for by this structural model is 85% and estimates made on the basis of this equation fall within ±8.78% of the mean in 95% of attempts.

The final wholesale price relation, concerning tom turkeys is presented in Table XXXIII. Average wholesale prices of this poultry category during the sample period were 36.56 ¢/lb. In the relationship with retail prices of hen turkey (as a proxy for unpublished retail tom turkey prices) statistical significance is achieved and a 10% change in retail prices is associated with a 4.0% change in wholesale prices. On the basis of this evidence, where retail tom turkey prices are proxied by the hen turkey price, the wholesale to retail margin is found to be

TABLE XXXIII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE WHOLESALE PRICE RELATION FOR TOM TURKEY

Independent Variable	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		60.7759	2.96	
F	-	2.1294	1.70	
M	-	1.7247	1.27	
A	-	1.6438	1.17	
M	-	2.4938	1.76	
J	-	3.3122	2.02	
J	-	1.7285	0.91	
A	-	- 0.9450	0.62	
S	-	- 3.5437	2.26	
O	-	- 7.7121	2.48	
N	-	- 7.5216	2.13	
D	-	-16.5062	2.43	
P_{rt}	¢/lb.	0.3353	1.48	0.3960
TREND	-	- 1.4888	2.67	
P_{rb}	¢/lb.	- 0.2171	1.85	-0.3715
P_{rp}	¢/lb.	0.1482	1.69	0.2284
P_{w3}	¢/lb.	- 0.1868	0.64	-0.1803
P_{w1}	¢/lb.	- 0.8238	2.30	-0.6847
PCQ_{r5}	lbs/mo.	12.6900	2.39	0.1057
INV_{5}	'000 lbs /mo.	0.0002	1.48	0.0803

S.E.E. = 2.3114 R^2 = 0.71 d.f. = 76
Mean = 36.5617 V.N. = 0.70

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

composed of distinct absolute and proportionate elements. The derived effect on the margin of a 1 ¢/lb. increase in proxied tom turkey prices at the retail level is an increase of 0.66 ¢/lb. in the magnitude of the wholesale to retail price spread. In further price relationships designed to assess substitutability characteristics, significance is obtained between wholesale prices of toms, and retail prices of beef and pork, and wholesale prices of broiler chickens. In the case of a 10% beef price increase the evidence indicates a 3.7% drop in tom turkey prices; similarly the unanticipated inverse relationship with broiler chickens shows that the tom turkey price response, to a 10% broiler chicken price rise, is -6.9%. This result further confirms the previous evidence that beef and poultry meats bear a complementary relationship. In the case of broiler chicken and tom turkey meats it is considerably more difficult to entertain such a contention seriously. For the purposes of this study the complementarity perceived between broiler chickens and tom turkey is presented as a vagary of the sampling period and data. Incorrect signs are also obtained in the relationships with per capita consumption and inventory. Ten percent changes in consumption and storage stocks are associated with a 1.1% and 0.8% changes in wholesale tom turkey prices. Since the constant percentage technique of determining the marketing margin is not being used exclusively, it is possible that wholesalers of toms adjust their prices by small amounts according to increases

or decreases in parameters such as per capita consumption and inventory levels. The trend variable shows a significant decline in wholesale prices of tom turkeys through the sample period of 1.5 ¢/lb./year.

It appears likely that the tom turkey wholesale price relation is affected by the presence of autocorrelation. That aside, variations in the explanatory variables have accounted for 71% of the variation in wholesale prices; and estimates derived using this equation will fall within ±12.64% of the mean in 95% of attempts.

In Figure XI the wholesale prices of each poultry meat category are depicted as deviations from January levels. For broiler chickens the months from May to September inclusive are noted for relatively higher prices. This evidence conforms with previous findings of stronger demands associated with the summer period. The peak in November arrives in the interim between Thanksgiving and Christmas. In the case of heavy chickens, prices reach their highest point in May but remain above January levels through the summer months. In February, March, and November it is suggested that some roasters are offered in the market place to satisfy those families whose Easter and Christmas poultry meat requests are exceeded by the purchase of full size turkeys. Very little variation in broiler turkey prices occurs throughout the year. In November prices rise, apparently in anticipation of Christmas demands; the December price low appears to be an attempt to

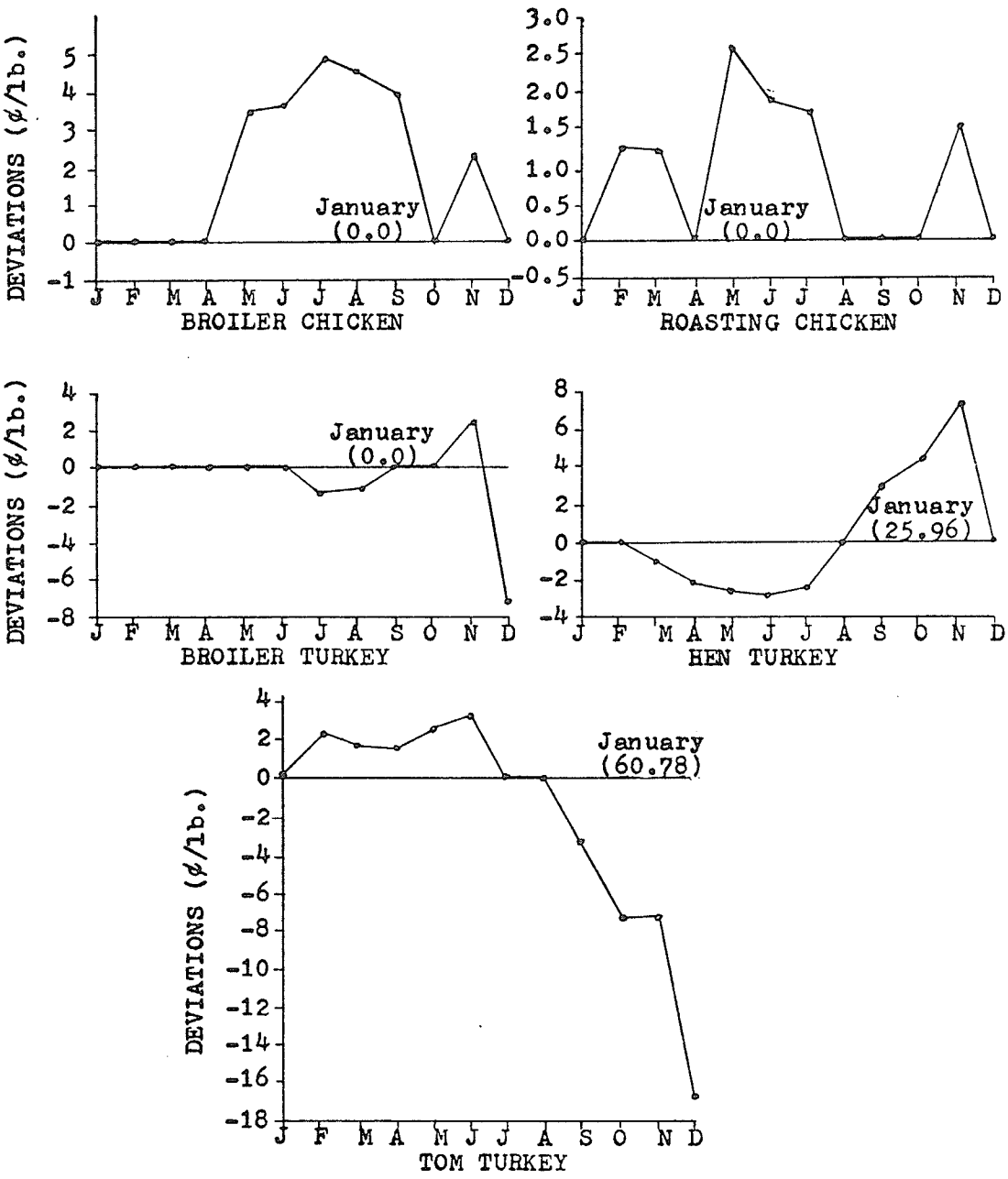

FIGURE XI

NET SEASONAL WHOLESALE PRICES REPRESENTED
AS DEVIATIONS ABOUT JANUARY PRICES
(1963-1970)

clear the usual Christmas surfeit of turkey meat from the market place. The monthly hen turkey wholesale price pattern resembles that of broiler turkey with some additional emphasis. Prices in general are below January levels during the summer months, the time during which chicken dominates the poultry meat market. Prices rise through September to November as retailers bid for available supplies to meet the Thanksgiving and Christmas demands. In the case of tom turkey the wholesale price pattern requires some disentangling. From February to July prices exceed January levels; from September to December prices fall below January levels. Relative to Figure X it appears that wholesale prices for toms are above January levels while stocks of toms are falling and the fall in wholesale prices occurs during the period when birds are being channelled into inventory. This suggests that, during the period analysed, Thanksgiving and Christmas demands are overestimated during the part of the production cycle when eggs are being hatched; then as toms enter the marketing channels to satisfy traditional demands, reassessments are made and a tardy stifling of production is attempted.

iv. Farm price relations. The results obtained from empirical analysis of the farm price relations for each category of poultry meat are presented in Tables XXXIV-XXXIX. Analysis of the monthly pattern in deflated farm prices for each poultry meat type are presented in Figure

XII. Several hypotheses are being examined in this model. The effects of per capita slaughter and inventory levels on farm price are examined initially. Then the effects of competing products are examined. Included are United States poultry meat products denoted by the landed price variable, the farm price of pork and the farm price of other poultry meats to the one being considered. The price of beef at the farm level was excluded from the analysis of competing products after preliminary analyses showed this variable to be inconsistent in both sign and statistical significance among the poultry meat categories. An assessment of the marketing margin is made using the retail price of poultry meat or its proxy, since retail prices for all categories of poultry meat were not available. Finally variations in farm prices associated with systematic trends over time are examined.

In the case of broiler chicken, deflated farm prices averaged 17.28 ¢/lb. in the sample. With results of analysis presented in Table XXXIV, the effects of per capita slaughter on farm price are revealed to be highly significant. A 10% increase in slaughter levels is associated with a decrease of 2.7% in farm prices of broiler chicken. Changes in inventory levels of broilers are found to be significantly related to farm prices although the economic impact is small; a 10% increase in inventory is associated with a 0.2% decrease in prices. In the relations between landed prices of United States poultry meat, and

TABLE XXXIV

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM PRICE RELATION FOR BROILER CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		7.4920	1.58	
F	-	0.2228	0.79	
M	-	0.8698	2.54	
A	-	0.7841	2.75	
M	-	1.3542	4.58	
J	-	1.2139	3.98	
J	-	1.8026	5.28	
A	-	1.6800	4.93	
S	-	1.4090	4.38	
O	-	0.6639	2.34	
N	-	0.9995	3.63	
D	-	0.5285	1.88	
P_{fp}	¢/lb.	0.0636	1.76	0.0966
P_{rc}	¢/lb.	0.3917	10.46	0.9388
TREND	-	0.2022	1.38	
P_{f4}	¢/lb.	-0.0913	0.83	-0.1184
INV	'0,000 lbs./mo.	-0.0004	1.36	-0.0210
$LNDP_{1}$	¢/lb.	-0.0974	0.89	-0.1710
PCQ_{f1}	lbs/mo.	-2.8181	4.79	-0.2673
S.E.E. = 0.4872		R^2 = 0.92	d.f. = 77	
Mean = 17.2747		V.N. = 1.39		

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

farm prices of hen turkey, the results show negative but insignificant relationships with respect to farm broiler chicken prices. The price of hogs at the producer level has a significant and positive relationship with broiler prices. A 10% change in the price of pork accounts for a 1.0% change in farm prices of broiler chickens. The relationship between farm and retail prices of broilers, used to denote the marketing margin, is shown to be highly significant. A constant percentage margin exists with a magnitude approaching 10%. The derived increase in the farm to retail broiler chicken price spread associated with a 1 ¢/lb. increase in retail prices is 0.61 ¢/lb. Finally, a significant increase in broiler chicken prices to producers associated with the passage of time is revealed in the order of 0.2 ¢/lb./year.

Explanatory variables in the broiler chicken relation account for 92% of the variation in farm prices. Use of this model for deriving estimates of farm prices will yield results within ±5.64% of the mean in 95% of attempts. If serial correlation of a positive nature exists in this relation, it is of lesser detriment than was associated with earlier relations.

In the case of roasting chickens, deflated farm prices through the period 1963-1970 averaged 20.30 ¢/lb. In the relation with per capita slaughter, significance is attained if tolerance of Type I error is relaxed slightly. Hence a 10% increase in slaughter of roasters is associated with a 0.3%

TABLE XXXV

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM PRICE RELATION FOR HEAVY CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		10.5193	2.47	
F	-	0.2404	0.69	
M	-	0.3765	1.07	
A	-	0.3850	1.10	
M	-	0.5670	1.45	
J	-	0.2051	0.48	
J	-	0.2178	0.52	
A	-	-0.3820	0.90	
S	-	-0.3061	0.72	
O	-	-0.2975	0.79	
N	-	0.1624	0.43	
D	-	0.3016	0.81	
P_{fp}	¢/lb.	0.0669	1.80	0.0864
P_{rc}	¢/lb.	0.3776	7.40	0.7704
TREND	-	-0.6680	4.94	
P_{f4}	¢/lb.	-0.2046	1.52	-0.2259
INV_2	'0,000 lbs /mo.	-0.0001	0.08	-0.0013
$LNDP_2$	¢/lb.	0.0194	0.38	0.0277
PCQ_{f2}	lbs/mo.	-3.2297	1.27	-0.0335

S.E.E. = 0.6738 R^2 = 0.94 d.f. = 77
Mean = 20.2967 V.N. = 0.72

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

decrease in farm price. Significance is not obtained between inventory of roasters and farm prices. In assessing the price effects of other commodities it is observed that United States prices of roasters landed in Canada do not significantly affect the Canadian farm prices of roasting chicken. In the relations between hogs and hen turkeys with respect to roaster prices, significant effects are obtained. For hogs, a 10% change in producer prices account for a 0.9% change in heavy chicken prices; for hen turkeys, however, a 10% increase in prices is associated with a fall of 2.3% in farm prices of roasters. Inspection of Figure XII confirms these findings. Hen turkeys and heavy chickens follow opposing patterns in prices through the year. An interpretation of complementarity in this instance will be postponed until consideration is made of possible missing variables. In assessing effects of the marketing margin retail broiler chicken prices are used to proxy retail prices of heavy chickens. The relationship obtained is highly significant and shows that a 10% change in retail price occasions a 7.7% change in farm prices. This evidence suggests a constant proportionate component in the margin. The derived effect of a 1¢/lb. increase in proxied retail prices of heavy chicken is to increase the farm to retail price spread by 0.62 ¢/lb. The highly significant results obtained for the trend variable show decreases in heavy chicken prices of 0.67 ¢/lb./year to primary producers over time.

The results for heavy chicken farm prices are likely affected by positive serial correlation. Nevertheless, the results show that the conceptual model has accounted for 94% of variation in the dependent variable. Estimates of farm prices will lie within ±6.64% of the mean price in 95% of the cases.

In the case of deflated farm prices of broiler turkeys, monthly average prices through the sample period were found to be 21.08 ¢/lb. Per capita farm slaughter of broiler turkeys accounts for a significant portion of variation in price. An increase of 10% in slaughter is associated with a 0.5% decrease in farm price. Inventory levels also affect price significantly with a 10% increase accounting for a 1.3% decrease in broiler prices. Significant effects are found between prices of United States broiler turkeys, farm prices of broiler chickens, and the price of broiler turkeys at the farm level. Farm pork prices do not significantly affect broiler turkey prices. A negative relationship between prices of United States and Canadian broiler turkeys in the order of -1.3% for 10% increases in the United States prices is evidence of complementarity but must be interpreted in light of possible missing variables. The magnitude of the change in farm broiler turkey prices arising from a 10% change in the price of broiler chickens is 2.9%. A highly significant relationship between farm and proxied retail prices of broilers is obtained which shows the margin composed of a constant percentage portion plus a fixed

TABLE XXXVI

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM PRICE RELATION FOR BROILER TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		9.8301	2.68	
F	-	-0.3836	1.35	
M	-	-0.3236	0.96	
A	-	-0.5313	1.49	
M	-	-1.0022	2.42	
J	-	-0.8552	2.01	
J	-	-0.4292	1.23	
A	-	-0.0846	0.29	
S	-	0.3690	1.28	
O	-	0.4179	1.23	
N	-	0.8630	2.59	
D	-	0.0244	0.06	
P_{fp}	¢/lb.	0.0100	0.38	0.0124
P_{rt}	¢/lb.	0.2515	4.95	0.5152
TREND	-	0.1275	0.80	
P_{f1}	¢/lb.	0.3575	3.28	0.2929
INV_3	'000 lbs /mo.	-0.0006	3.44	-0.1327
$LNDP_3$	¢/lb.	-0.0729	1.61	-0.1265
PCQ_{f5}	lbs/mo.	-4.0928	2.03	-0.0471

S.E.E. = 0.5567 R^2 = 0.95 d.f. = 77
Mean = 21.0821 V.N. = 1.08

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

portion. The effect of a 10% change in retail prices of hen turkey is a 5.2% change in farm prices of broiler turkey. A 1 ¢/lb. increase in proxied retail broiler turkey prices is found to be associated with a 0.75 ¢/lb. increase in the farm to retail marketing margin. Trends associated with annual time periods do not affect broiler prices significantly.

Some likelihood of positive serial correlation exists in the conceptual model presented in Table XXXVI. Explanatory variables account for 95% of variation in farm broiler turkey prices. In addition, estimates derived from the structural equation will fall within ±5.28% of the sample mean, 95% of the time.

In the case of hen turkeys, deflated farm prices were found to be 22.30 ¢/lb. in the average month between 1963-1970. The structural equation was estimated in its linear form by taking logs of the variables. The relationship with per capita farm slaughter is significant and reveals that a 10% increase in slaughter levels is associated with a 0.4% decrease in farm price. The relationship with inventory levels is significant also and indicates a decrease of 1.0% in hen turkey prices associated with a 10% increase in storage. Commodities hypothesized to be substitutes for hen turkey are found to be significant and carrying the expected signs. Changes in the order of 10% in the prices of pork, broiler chickens and United States hen turkeys landed in Canada are associated with changes of 0.8%, 1.4%, and 1.3% respectively in the farm price of hen turkeys. In assessing

TABLE XXXVII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM PRICE RELATION FOR HEN TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		0.5331	1.89	
F	-	-0.0116	1.55	
M	-	-0.0240	3.03	
A	-	-0.0246	2.44	
M	-	-0.0161	1.27	
J	-	-0.0182	1.32	
J	-	0.0053	0.34	
A	-	0.0348	1.90	
S	-	0.0665	3.17	
O	-	0.0826	3.77	
N	-	0.0882	3.87	
D	-	0.0431	2.64	
Log P_{fp}	¢/lb.	0.0809	1.83	0.0809
Log P_{rt}	¢/lb.	0.4082	4.11	0.4082
TREND	-	-0.0094	0.59	
Log P_{f1}	¢/lb.	0.1389	1.38	0.1389
Log INV_4	'000 lbs /mo.	-0.0996	2.62	-0.0996
Log $LNDP_4$	¢/lb.	0.1301	1.95	0.1301
Log PCQ_{f4}	lbs/mo.	-0.0378	2.24	-0.0378

S.E.E. = 0.0146 R^2 = 0.90 d.f. = 77
Mean = 1.3484 V.N. = 1.18

[a] Critical values of student-t at α = 0.10 are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

the marketing margin a highly significant relation is found with respect to retail prices of hen turkeys. A 10% retail price change accounts for a 4.1% change in farm prices. This indicates that the margin contains a constant percentage portion. As well, the effect on the margin associated with a 1 ¢/lb. increase in retail prices of hen turkeys, is derived to be an 0.59 ¢/lb. increase in the farm to retail price spread. With respect to the passage of time no significant effect is associated with hen turkey prices.

The structural model developed to explain demands at the farm level for hen turkeys has accounted for 90% of the variation in farm prices. Estimates derived from this relation will in a majority of cases fall within ±2.16% of the average price.

In the case of tom turkeys, prices were once again estimated at the farm level using a Cobb-Douglas model translated into its linear form using logarithms. Average deflated price during the sample period was 21.57 ¢/lb. A significant relation is found between per capita slaughter and farm prices. Following a 10% increase in slaughter levels, prices are adjusted downwards by 0.5%. In the relationship with inventory levels, highly significant results indicate that tom turkey prices fall 1.0% in response to a 10% increase in stocks. Of the three commodities evaluated as substitutes for tom turkey, statistical significance is attained for each; however an unanticipated negative relationship is found to exist between hogs and tom turkeys.

TABLE XXXVIII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM PRICE RELATION FOR TOM TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Price Flexibility
Constant		-0.5103	1.42	
F	-	-0.0175	1.50	
M	-	-0.0390	2.98	
A	-	-0.0435	3.36	
M	-	-0.0389	3.07	
J	-	-0.0258	1.92	
J	-	-0.0214	1.48	
A	-	-0.0121	0.82	
S	-	0.0331	2.10	
O	-	0.0587	3.30	
N	-	0.0495	2.62	
D	-	0.0089	0.65	
Log P_{fp}	¢/lb.	-0.1549	2.75	-0.1549
Log P_{rt}	¢/lb.	0.8092	5.93	0.8092
TREND	-	0.1112	5.29	
Log P_{f1}	¢/lb.	0.4402	2.60	0.4402
Log INV_5	'000 lbs /mo.	-0.1030	4.89	-0.1030
Log $LNDP_5$	¢/lb.	0.3433	3.76	0.3433
Log PCQ_{f5}	lbs/mo.	-0.0468	3.05	-0.0468

S.E.E. = 0.0199 R^2 = 0.86 d.f. = 77
Mean = 1.3338 V.N. = 1.19

[a] Critical values of student-t at α = 0.10 are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

Changes in farm prices of toms associated with 10% changes in pork, broiler chicken, and United States tom turkeys landed in Canada amounted to -1.6%, 4.4%, and 3.4% respectively. Evidence indicating complementarity between pork and tom turkey must be tempered by some consideration of missing variables. A constant percentage type of marketing margin is indicated by the highly significant relation with the retail price of hen turkeys (a proxy for retail tom turkey prices). A change of 10% in retail prices occasions an 8.1% change in farm prices. The effect on the marketing margin associated with a 1 ¢/lb. increase in proxied retail tom turkey prices is found to be an increase of 0.19 ¢/lb. in the magnitude of the margin. Tom turkey prices at the farm level are found to be increasing with the passage of time by 0.11 ¢/lb./year.

Explanatory variables in the tom turkey relation account for 68% of the variation in farm prices. Use of this model for deriving estimates of farm prices of toms will yield results within ±2.98% of the average price 95% of the time. Though not confirmed, positive serial correlation may influence the calculation of standard errors.

In Figure XII farm prices are represented for each of the poultry meat categories as deviations about January-level prices. For broiler chicken the months of January and February are noted for lowest prices with July prices peaking at 1.8 ¢/lb. over January levels. In the case of roasters little variation in prices through the year is noted with May prices reaching a high at 0.6 ¢/lb. over January levels.

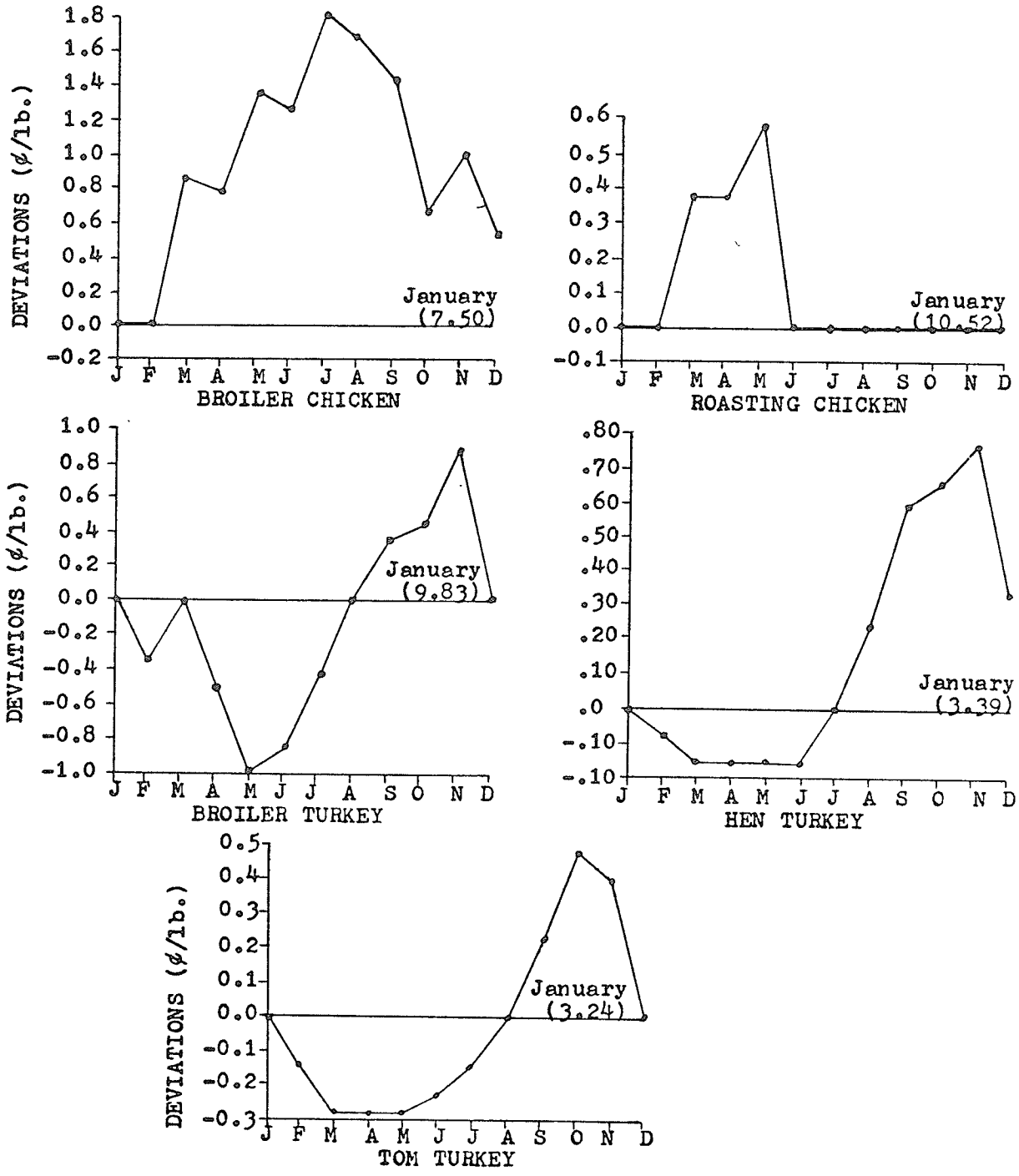

FIGURE XII

NET SEASONAL FARM POULTRY PRICES REPRESENTED
AS DEVIATIONS ABOUT JANUARY PRICES
(1963-1970)

Inspection of Figure XII reveals that some stimulus in prices in the early part of the year may convince producers to allocate resources to the production of roasters. For broiler turkeys, prices vary ± 1.0 ¢/lb. from January levels throughout the year. For hens and toms price variations of a lesser magnitude are revealed. These three poultry meats follow similar price patterns through the year, being below January levels until August and exceeding January prices through the fall period until Christmas. For turkey meats the farm price patterns are consistent with the existence of strong traditional demands in the latter part of the year.

v. Farm production relations. In Tables XXXIX-XLIII the results of analysis of the farm supply relations for each category of poultry meat are presented. In this study little emphasis has been placed on supply conditions but the models developed would be incomplete without including an attempt at estimating the factors that account for variations in production levels. In Figure XIII a pictorial representation of farm supplies of the poultry meat subclasses varying from January levels is presented. In addition to the analysis of monthly patterns of production, four hypotheses were outlined for examination in the farm supply relations. Farmer expectations were identified by lagging farm prices and the numbers of chicks and poults placed for production of birds in the different poultry categories. Lagged costs of production proxied by the prices per hundredweight of feed were included as well.

Finally an assessment is made of changes associated with the passage of time. The models were specified in multiplicative (Cobb-Douglas) form but estimation of parameters was undertaken linearily by taking logarithms.

In the case of broiler chickens, presented in Table XXXIX, monthly farm production averaged 32,041,000 pounds during 1963-1970. Each of the hypotheses being evaluated were accepted at high levels of significance. Changes in farm supply of broiler chickens resulting from 10% changes in lagged farm price, lagged placements, and lagged costs amounted to 4.0%, 2.5%, and -14.1%. Production is also found to have net increasing trend through the sample period of 160.6 lbs./month/year.

In this supply relation the likelihood of positive serial correlation is diminished from levels associated with previous relations. Explanatory variables in the broiler chicken relation account for 96% of the variation in farm production. When employed in deriving estimates of farm supply the conceptual model outlined will produce results within ±1.00% of the mean in 95% of cases.

Average production of roasting chickens amounted to 4,138,100 pounds during the sample period. Lagged farm prices, in relation to current supply, are found to be significant, with a 10% change in lagged price associated with an 8.9% change in supply. Lagged placements also achieve significance and a 10% change is associated with a 2.7% change in production. Lagged costs, although of the

TABLE XXXIX

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM SUPPLY RELATION FOR BROILER CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Elasticity
Constant		3.8347	12.17	
F	-	-0.0406	3.62	
M	-	-0.0135	1.11	
A	-	0.0052	0.46	
M	-	0.0357	3.10	
J	-	0.0153	1.14	
J	-	0.0346	2.62	
A	-	0.0354	2.60	
S	-	0.0179	1.27	
O	-	0.0167	1.31	
N	-	0.0241	1.98	
D	-	-0.0452	3.69	
Log PCMT lag	'000/mo.	0.2532	4.05	0.2532
Log COST lag	¢/lb.	-1.4074	8.90	-1.4074
Log $P_{f,lag}$	¢/lb.	0.4025	3.48	0.4025
TREND	-	0.1606	8.67	
S.E.E. = 0.0024		R^2 = 0.96		d.f. = 80
Mean = 4.5057		V.N. = 1.43		

[a] Critical values of student-t at α = 0.10 are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

TABLE XL

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM SUPPLY RELATION FOR HEAVY CHICKEN

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Elasticity
Constant		1.6144	1.70	
F	-	-0.0517	1.72	
M	-	-0.0718	2.17	
A	-	-0.0457	1.49	
M	-	-0.0591	1.91	
J	-	-0.0909	2.47	
J	-	-0.0764	2.12	
A	-	-0.0754	2.05	
S	-	-0.0672	1.74	
O	-	0.0266	0.77	
N	-	0.0254	0.77	
D	-	0.0251	0.76	
Log PCMT lag	'000/mo.	0.2689	1.49	0.2689
Log COST lag	¢/lb.	-0.5468	0.95	-0.5468
Log P f,lag	¢/lb.	0.8876	2.50	0.8876
TREND	-	0.1961	3.51	
S.E.E. = 0.0601		R^2 = 0.62		d.f. = 80
Mean = 3.6168		V.N. = 0.69		

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

correct sign, are not found significant at desired levels. Production of heavy chickens are found to be increasing significantly with the passage of time by 196.1 lbs./month/year.

The extent of autocorrelation in the supply relation for roasters approximates levels occurring in previous relations. The multiple coefficient of determination indicates the percentage of variation accounted for is 62%. 95% of estimates derived using this relation will lie within ±3.32% of the average level of production.

In the case of broiler turkeys, supply averaged 4,627,000 pounds monthly during the time-series studied. The relationship with lagged farm prices is significant and indicates that a 6.5% change in supply is associated with a 10% change in the lagged price. Lagged placements are found to be highly significant in accounting for changes in farm supply with a 10% change in the numbers of poults occasioning a 3.8% change in broiler turkey production. The costs of turkey grower feed lagged three months are significant in accounting for variations in broiler turkey supply but the directional relationship obtained is contrary to expectations. A 10% change in feed costs is associated with a 1.8% change in the same direction in broiler supplies. The magnitude of the effect of lagged costs, in conjunction with the incorrect sign, are reasons for querying the appropriateness of a three month lag in the proxied costs of production variable. Factors associated

TABLE XLI

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM SUPPLY RELATION FOR BROILER TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a]	Elasticity
Constant		1.3016	2.62	
F	-	0.0095	0.38	
M	-	0.0999	4.02	
A	-	0.0159	0.64	
M	-	0.0804	3.16	
J	-	0.0888	3.49	
J	-	0.0863	3.42	
A	-	0.0841	3.34	
S	-	0.0575	2.21	
O	-	0.1029	3.82	
N	-	0.1158	4.29	
D	-	0.1473	5.44	
Log PCMT lag	'000/mo.	0.3838	5.87	0.3838
Log COST lag	¢/lb.	0.1826	1.34	0.1826
Log $P_{f,lag}$	¢/lb.	0.6449	1.92	0.6449
TREND	-	0.3999	5.60	
S.E.E. = 0.0491		R^2 = 0.91		d.f. = 80
Mean = 3.6653		V.N. = 2.21		

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

with the passage of time are highly significant in explaining increases in the production of broiler turkeys of 399.9 lbs./month/year.

In the broiler turkey supply relation, with a Von Neumann ratio of 2.21, the likelihood of autocorrelation inhibiting the value of results is almost non-existent. Variations in the explanatory variables have accounted for 91% of variation in supply. Estimates of broiler turkey production derived from this equation will lie within ±2.68% of the average level in 95% of cases.

In the case of hen turkeys, the average supply of product at the farm level was 2,135,900 pounds monthly through 1963-1970. Lagged farm prices achieved significance in accounting for variations in supply with a 10% change in price accounting for 10.9% changes in supply. Neither lagged placements of poults nor lagged costs of turkey grower feed achieved significant levels in explaining variation in hen turkey production. Factors associated with the passage of time proved to be significant, indicating annual increases in farm production of hen turkeys of 229.9 lbs./month/year.

Explanatory variables in the hen turkey relation account for 96% of variation in farm supply. If this conceptual model is applied to obtaining estimates of production, in 95% of attempts the results will fall within ±6.02% of the mean. Some evidence exists to indicate the presence of positive serial correlation in the farm

TABLE XLII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM SUPPLY RELATION FOR HEN TURKEY

Independent Variable	Units	Net Regression Coefficient	Student-t [a]	Elasticity
Constant		1.0977	1.51	
F	-	-0.0606	1.00	
M	-	0.0173	0.23	
A	-	0.1266	1.64	
M	-	0.2879	4.19	
J	-	0.3872	6.74	
J	-	0.7018	13.19	
A	-	1.0321	20.42	
S	-	1.0995	18.09	
O	-	1.1127	17.60	
N	-	0.9764	16.14	
D	-	0.8761	15.91	
Log PCMT lag	'000/mo.	0.0387	0.66	0.0387
Log COST lag	¢/lb.	-0.0435	0.16	-0.0435
Log P f,lag	¢/lb.	1.0928	2.20	1.0928
TREND	-	0.2299	3.20	
S.E.E. = 0.1002		R^2 = 0.96		d.f. = 80
Mean = 3.3296		V.N. = 1.47		

[a] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

supply relation for hen turkey.

Farm supplies of tom turkey on a monthly basis averaged 3,220,300 pounds during the sample period. In relating supplies to lagged farm prices the desired level of significance is not attained. In relating supplies to lagged placements a high degree of significance is obtained. Associated with a 10% change in lagged placements is a 6.1% change in farm production. Relative to changes in lagged costs no measurable changes are recorded in the production of tom turkeys. Factors, such as technology, associated with the passage of time play a significant role in explaining variations in farm supply of tom turkeys of 206.1 lbs./month/year.

The limited possibility of serial correlation in the farm supply of tom turkey relation imparts a degree of credibility to estimates based on this equation. In 95% of such estimates the results will lie within ±5.84% of the average production level. Explanatory variables account for 97% of variation in the structural model denoting the production of tom turkey.

In Figure XIII the monthly patterns in production of each category of poultry meat are represented as deviations about January levels. As anticipated for broiler chickens, supplies during the summer months exceed January levels in response to stronger summer demands for chicken. For heavy chickens the pattern differs from broilers in that winter supplies exceed summer supplies. Nevertheless the

TABLE XLIII

RESULTS OBTAINED FROM EMPIRICAL ANALYSIS OF THE FARM SUPPLY RELATION FOR TOM TURKEY

Independent Variables	Units	Net Regression Coefficient	Student-t[a/]	Elasticity
Constant		1.2666	2.45	
F	-	0.0029	0.05	
M	-	0.0443	0.58	
A	-	0.2306	2.92	
M	-	0.2311	3.27	
J	-	0.2644	4.54	
J	-	0.3643	6.71	
A	-	0.5088	9.86	
S	-	0.4617	7.43	
O	-	0.5399	8.35	
N	-	0.4934	7.97	
D	-	0.3405	6.09	
Log PCMT lag	'000/mo.	0.6134	10.38	0.6134
Log COST lag	¢/lb.	0.0325	0.11	0.0325
Log P f,lag	¢/lb.	0.2083	0.63	0.2083
TREND	-	0.2061	3.51	
S.E.E. = 0.1024		R^2 = 0.97		d.f. = 80
Mean = 3.5080		V.N. = 1.76		

[a/] Critical values of student-t at $\alpha = 0.10$ are 1.293 for the one-tailed test and 1.665 for the two-tailed test.

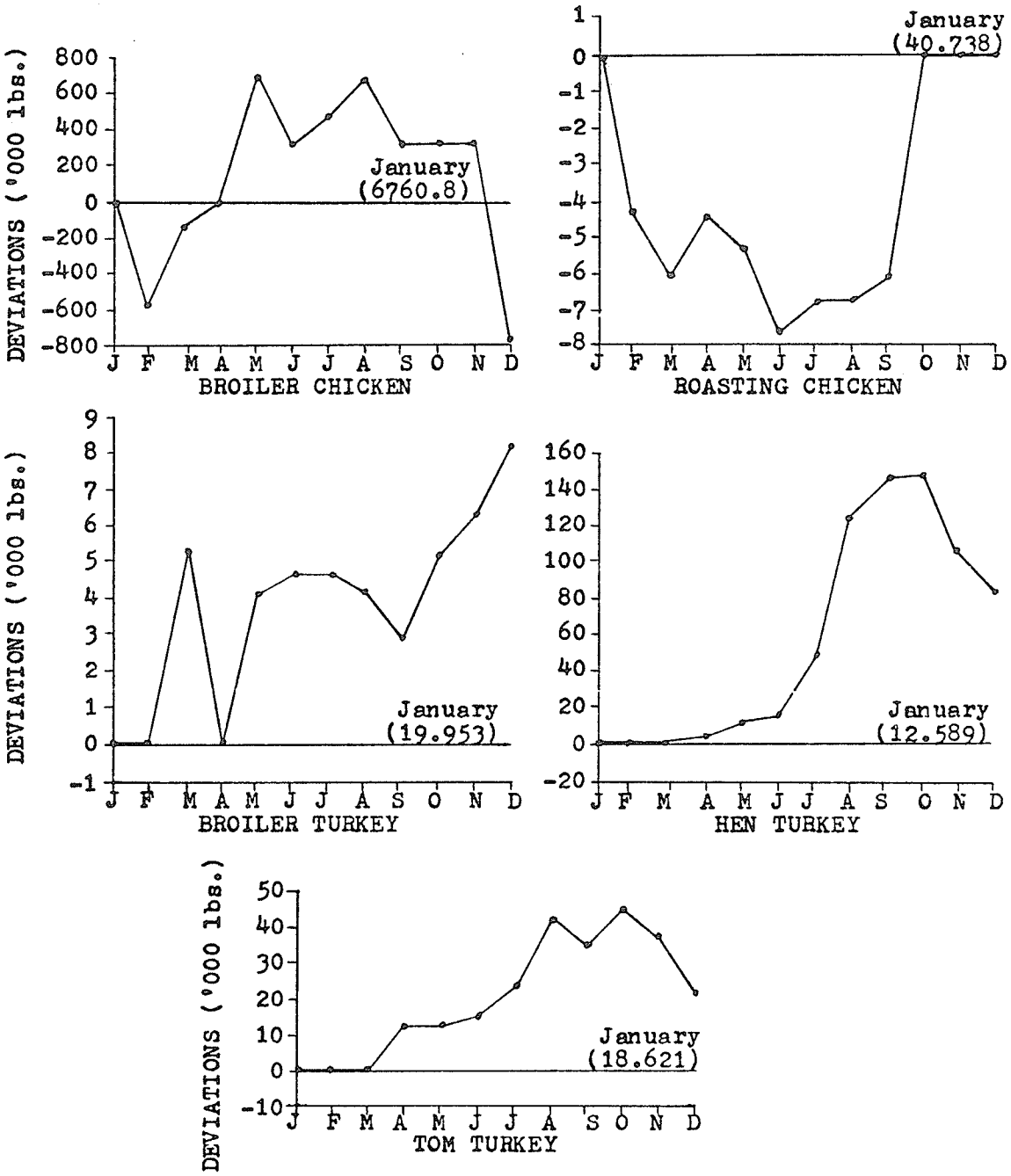

FIGURE XIII

NET SEASONAL QUANTITY SLAUGHTERED IN REGISTERED STATIONS IN CANADA REPRESENTED AS DEVIATIONS ABOUT JANUARY LEVELS (1963-1970)

magnitude of the deviation in June relative to average monthly production is less than 0.2%. For the three turkey categories, lows in farm supply are associated with the early months of the year. During the month of March broiler turkey supplies reach a peak for the Easter market; during the month of September it is likely that slaughter and processing facilities are dedicated to heavier weight turkeys rather than broilers. Towards year end broiler turkey supplies rise to meet Christmas demands. Hen turkey supplies reach their peak in October and fall to year end. Supplies of toms are highest in August and October, leaving sufficient time for these birds to be slaughtered, processed, and otherwise made ready for Thanksgiving and Christmas.

C. PRICE PREDICTION

The third objective of this study is to apply the models to the task of predicting monthly prices of the poultry meat subclasses at each market level during 1971. As Friedman (10:1953:Part I) contends, the validity of every model should be tested according to its ability to predict. A priori, the models are not expected to yield good results in predicability due to the presence of positive serial correlation and, in some cases, due to the low magnitudes of the multiple coefficient of determination. A prime concern of this study has been to obtain "good" statistical estimates of structural parameters. In specifying the models, choosing an estimation technique and analysing the poultry meats

industry, attention was given to eliminating statistical inadequacies such as multicollinearity which could give rise to errors in the structural estimates, though it is recognized that such effects may enhance the predictive ability of a model. Hence no additional effort was expended in developing models especially suited to predicting prices. During the early months of 1971, for which predictions will be made, certain conditions were in force in the Canadian poultry meat markets that were not present during the period for which empirical analysis was carried on and structural coefficients were estimated. The policy of eliminating inventory by subsidizing the interprovincial transfer of poultry meat, initiated in Quebec, had diverse ramifications to the market mechanisms of other provinces. For reasons such as this, predictions from the models developed in this study are expected to be poor.

Prices were predicted for the months of 1971. Since 1971 data for the exogenous variables in the models were available, forecasts of these variables were not made. At the retail level only two price series were used in the study and as a consequence price forecasts were limited to broiler chicken and hen turkey categories. In Figure XIV the predictions obtained from the retail model are presented along with the actual monthly prices which prevailed during 1971.

At the farm and wholesale levels a simultaneous model was developed, and empirically analysed using two-stage least

squares. In predicting prices from this model, it was necessary to obtain the first stage estimated values of the independent endogenous variables as a preliminary step before solving the structural equations for the desired 1971 monthly predictions. Admittedly, this choice of procedure is not completely correct, since the simultaneous technique of analysing the model dictated that the predictions be obtained simultaneously as well. However, such a solution was considered infeasible due to the many variables in each stage I equation, the varying numbers of equations in each simultaneous set, and the time element. In Figure XV and XVI the predictions of wholesale and farm prices of the poultry meat subclasses, obtained from the farm-wholesale model, are presented along with the actual monthly prices which prevailed during 1971.

By inspection of Figure XIV, it can be seen that deflated retail predicted prices of broiler chicken differed from actual prices by a maximum of 7.67 ¢/lb. in October, while predicted prices of hen turkey differed from actual deflated retail prices by 1.28 ¢/lb. in April. As well the retail price model for broiler chickens predicted incorrect directions of change in monthly prices during the first seven months of 1971; whereas for hen turkeys the direction of change was predicted correctly for ten months within the year.

In Figure XV the months noted for the greatest discrepancy in predicted deflated wholesale prices from actual prices are: in the case of broiler chickens the

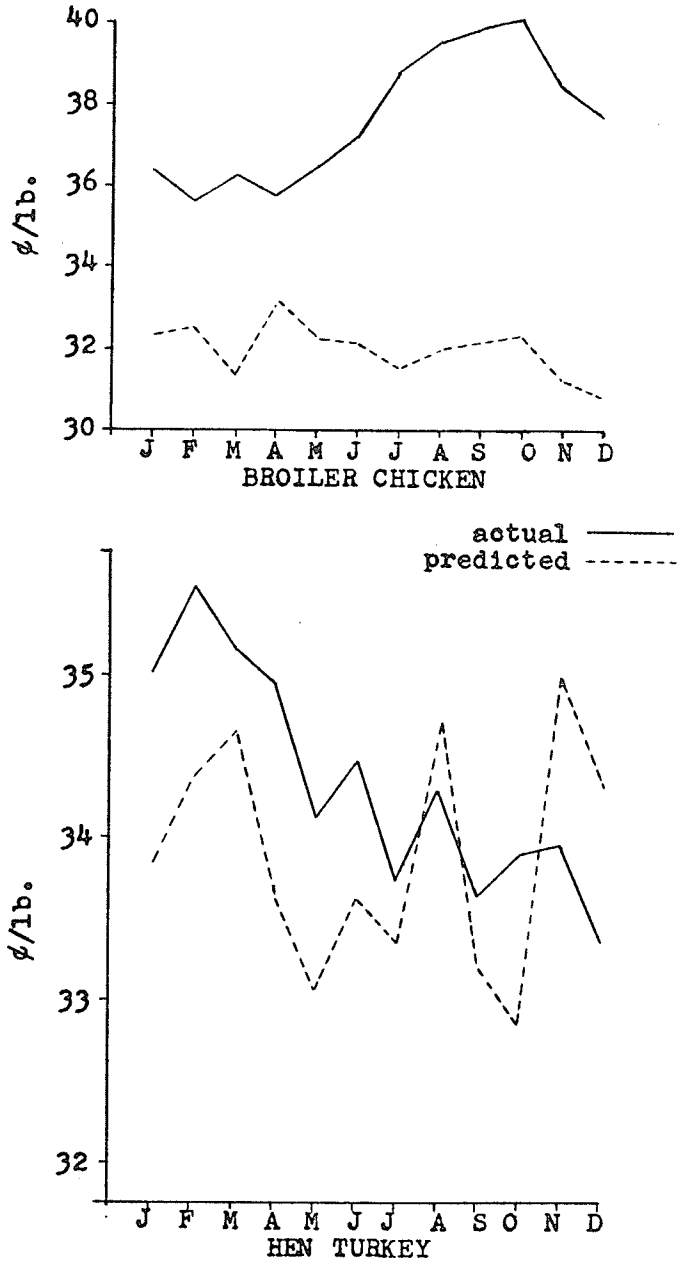

FIGURE XIV

DEFLATED RETAIL PRICES OF POULTRY MEATS,
ACTUAL AND PREDICTED - 1971

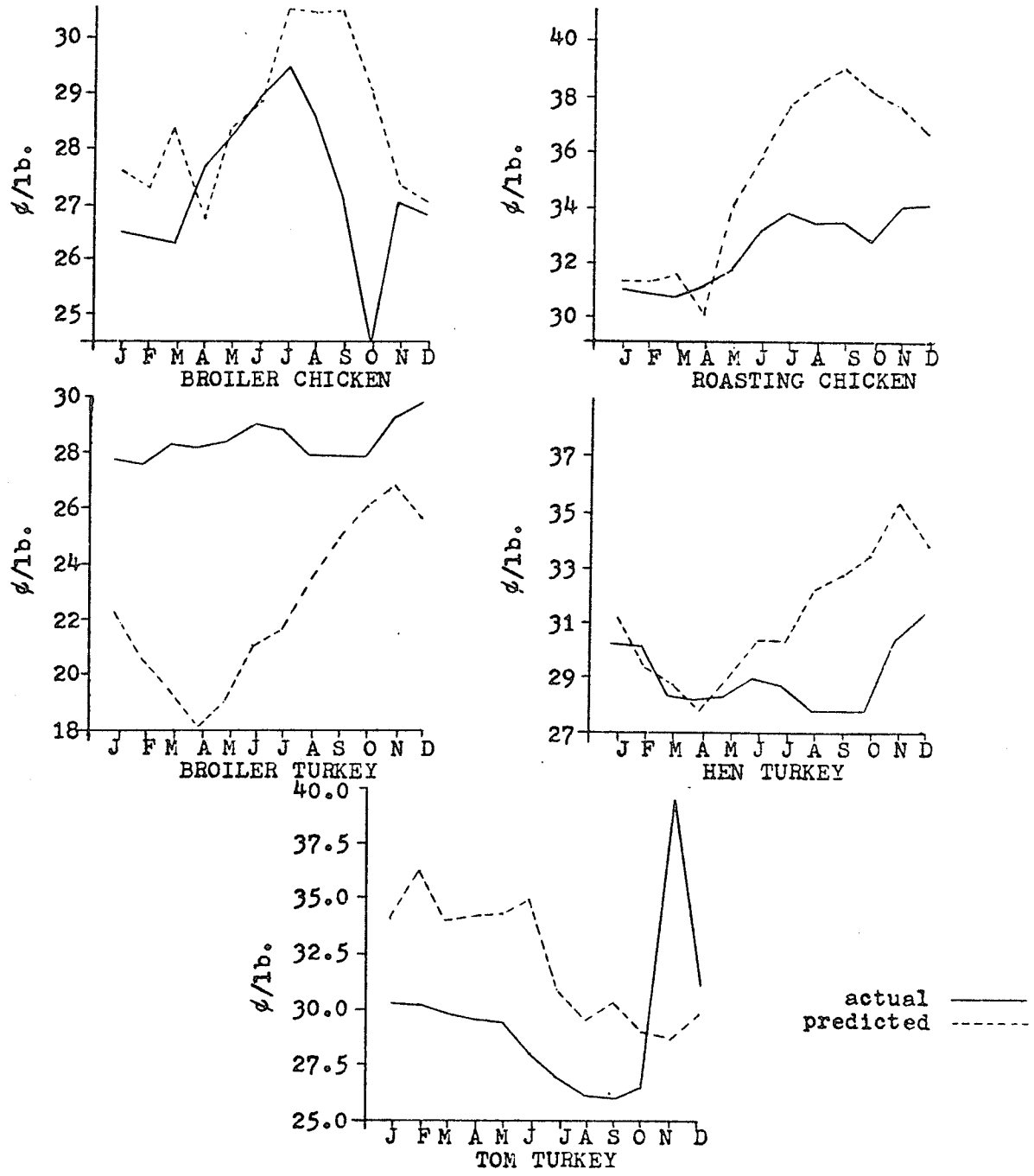

FIGURE XV

DEFLATED WHOLESALE PRICES OF POULTRY MEATS,
ACTUAL AND PREDICTED - 1971

predicted price during October varied by 4.55 ¢/lb. from the actual price; in the case of roasting chicken the predicted price during September varied by 5.57 ¢/lb. from the actual price; in the case of broiler turkey the predicted price during April varied by 10.67 ¢/lb. from the actual price; in the case of hen turkey the predicted price during October varied by 5.61 ¢/lb. from the actual price; and in the case of tom turkey the predicted price during November varied by 10.72 ¢/lb. from the actual price. The predicted directions of change in forecasted monthly deflated wholesale prices of the poultry meat categories were correct for the majority of cases.

In Figure XVI the months noted for the greatest discrepancy in predicted deflated farm prices are: in the case of broiler chickens the predicted price during August varied by 0.62 ¢/lb. from the actual price; in the case of roasting chickens the predicted price during March varied by 1.70 ¢/lb. from the actual price; in the case of broiler turkey the predicted price during November varied by 3.55 ¢/lb. from the actual price; in the case of hen turkey the predicted price during March varied by 2.98 ¢/lb. from the actual price; and in the case of tom turkey the predicted price during June varied by 3.20 ¢/lb. from the actual price. For each poultry meat category the projected monthly direction of change in deflated farm prices was correct for a majority of months

In earlier discussion the abilities of the models to

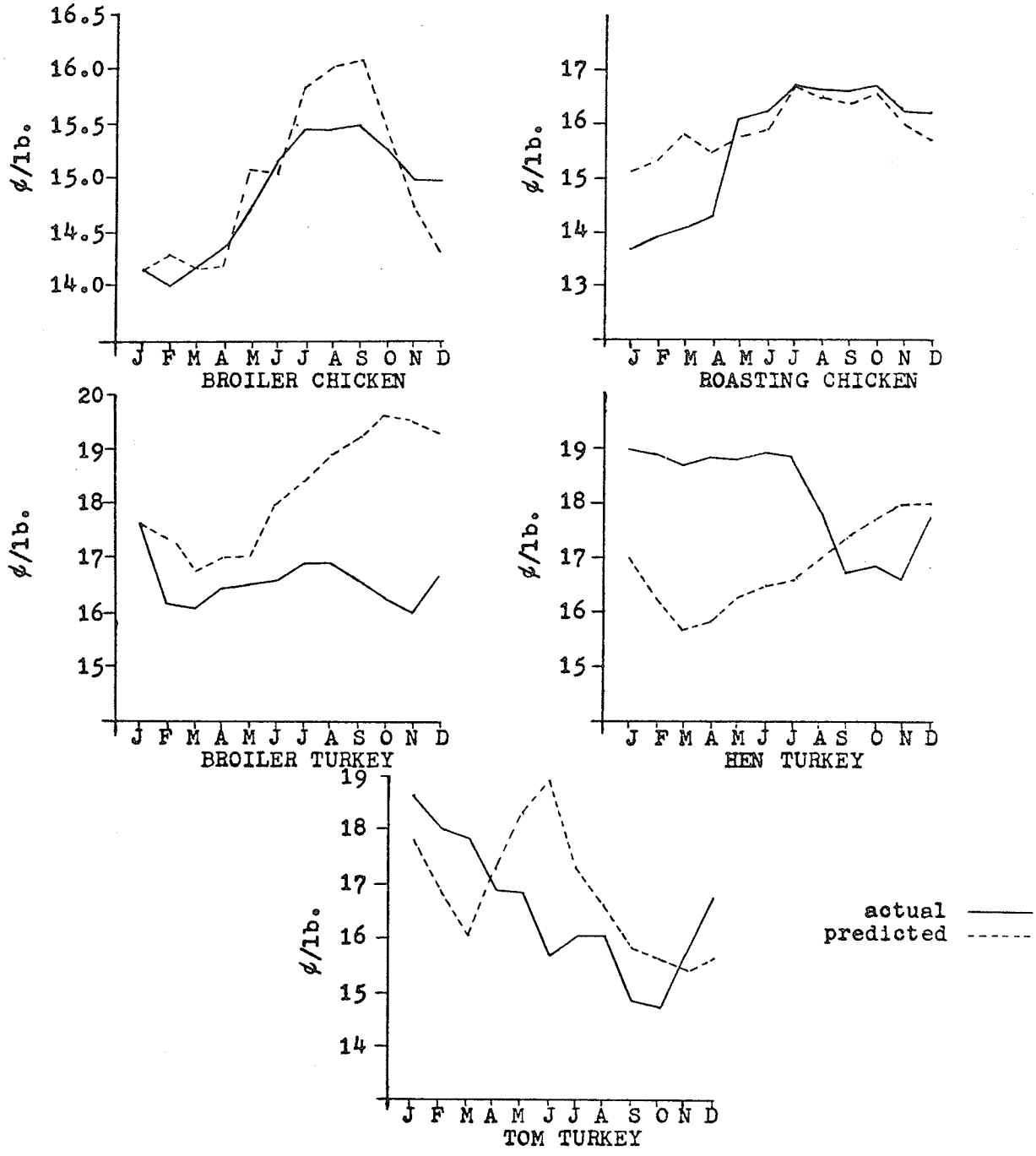

FIGURE XVI

DEFLATED FARM PRICES OF POULTRY MEATS,
ACTUAL AND PREDICTED - 1971

make accurate predictions were questioned, and rationalized in light of statistical problems of autocorrelation and low explanatory power; as well, market disturbances not accounted for in the period analysed were associated with the period to which projections were being made. Subsequently, considering the results presented in the preceding pages, it is necessary to conclude that the objective of price forecasting has not been adequately satisfied. The models are shown to perform poorly, with little consistency between the poultry meat subclasses, but in general the results are best for deflated farm prices. In the event that revisions are attempted, it is at the farm level that information is needed for input to supply regulation policies and therefore efforts at refining the predictive abilities of the models should be concentrated at the farm level.

D. SUMMARY AND DISCUSSION OF RESULTS

As outlined in Chapter I, the study presented in this thesis was undertaken to satisfy three primary objectives:

1. To discuss and provide quantitative measures of the determinants of demand, including:

i) seasonal variations in quantities consumed;

ii) demand elasticity with respect to prices and income;

iii) the effects of competing products such as beef, pork, and the other poultry meats;

iv) the impact on Canadian poultry markets of

conditions in the United States; and

v) factors which induce Canadian suppliers to move poultry commodities into or out of inventory holdings;

2. To assess the relationship between prices at each market level by an examination of the structure of marketing margins; and

3. To provide a model for use in making short-term forecasts of poultry meat prices in 1971.

In Chapter II, the results obtained from other similar studies were presented. The benefits of such a comprehensive review of the literature are two-fold:

1. to assist in the formation of hypotheses; and

2. to provide additional information in order that the results obtained in this study can be further evaluated for consistency with previous studies.

The first half of Chapter III was addressed to reviewing principles of economic theory of general importance throughout the study. Hence demand elasticity concepts, deflation, interregional price relationships, and marketing margins were considered singly, rather than being considered with respect to the individual poultry meat subclasses. In the second half of Chapter III the analytical framework designed to satisfy the objectives of the study was presented. Two conceptual models were hypothesized and discussed along with their econometric implications and a simultaneous estimation technique. Demands at the retail level were isolated for study in one model. This approach

was chosen due to unavailability of data for all of the poultry meat categories at the retail level, and a need to reduce the overall complexity of the analysis. A second model was conceptualized for analysis of the farm and wholesale market levels of the poultry industry.

In Chapter IV the results of empirical analysis of the models and their component behavioural relationships, through the period 1963-1970, were presented for each of the poultry meat subclasses. The hypotheses which were posited to satisfy the objectives of the study were evaluated for economic as well as statistical credibility. Seasonal patterns in prices, imports, inventory and production were plotted and discussed. The models were applied to forecasting monthly prices of the poultry meats at each market level in 1971. Then the results of prediction were presented in graphical form and discussed. Finally the relationships are to be reviewed in light of the objectives prior to suggesting limitations, conclusions and implications in Chapter V.

In satisfying the first objective, several sub-objectives must be considered individually.

Seasonal variations in quantities of poultry meats consumed in Canada are found to be associated with traditional festive occasions. For turkey meats in general, the Easter, Thanksgiving and Christmas holidays serve to bolster consumer demands. Chicken meats are found to be preferred by consumers during the summer relative to the

winter months.

With respect to prices, the demand elasticities of the poultry meat subclasses, derived from price flexibility coefficients obtained in the analysis, are larger in magnitude than expected. Consumer responses to price changes in the poultry meat subclasses are found to be highly elastic in nature, but these results should be treated cautiously. From an analysis of cross-section data in which long-term income elasticities were estimated, it has been determined that there is no statistically significant turkey consumption response to changes in income. With respect to consumption of chicken meats, consumer responses are inelastic when associated with increases in income; therefore both chicken and turkey meats are denoted as normal economic goods, or necessities.

The relationships between poultry meats and other meat products were assessed with competition between the poultry meat subclasses, and beef, pork and alternate poultry meats being considered. At the retail level it has been determined that beef, pork and hen turkey meats are substitutes for broiler chicken. As well, pork will substitute for hen turkey; but beef and hen turkey meats bear a complementary relationship at the retail level. At the wholesale level pork is found to substitute for the poultry meats; beef is found to bear an insignificant relationship to the lighter weight poultry categories and a complementary relationship to the larger birds. In general, the

relationships found between wholesale prices of the different poultry meat subclasses could be considered to depict substitutability, with the larger birds substituting for their lighter weight counterparts, but not the antithesis. A notable exception exists wherein broiler chicken and tom turkey are found to have a significant complementary relationship at the wholesale level. At the farm market level, pork appears to have a substitute relationship with all the poultry meat categories except tom turkey, this relationship being complementary in nature. With respect to the relationship between individual poultry meat categories it is suggested that competitive behaviour occurs wherein the heavier weight birds complement the lighter weights, but the lighter weights substitute for their heavier counterparts.

Impacts on Canadian poultry markets of conditions in the United States have been evaluated at the retail, wholesale and farm levels in the models presented in previous sections. At the retail level an insignificant relationship exists between Canadian retail prices of broiler chicken and hen turkey and United States wholesale prices of the same poultry meat categories. In the relationships hypothesized to explain net imports of the poultry meat subclasses, statistically significant effects are found between the computed wholesale price differential variables and net imports of the broiler turkey and tom turkey categories. However, the results also show decreases in net imports of broiler turkey as the range widens between Canadian wholesale

prices of this category, and the United States wholesale prices adjusted to reflect costs of importing such as tariffs and currency exchange. This result is contrary to expectations. The effects of the landed price variable in explaining Canadian farm prices are statistically significant for turkey meats but are insignificant for chicken. In the case of broiler turkeys, the results unexpectedly show increases in Canadian farm prices associated with decreases in landed prices.

Factors which cause changes in inventory holdings have been hypothesized for each of the poultry meat categories. The results show that increases in farm production are associated with increases in inventory levels for all categories. An increase in domestic consumption of roasting chicken is associated with a decrease in inventory of this meat, as expected; but in the case of hen turkeys, the direction of change is the same for domestic consumption and inventory. It is conceivable that levels of inventory of hen turkeys are being increased during certain times of the year (prior to Thanksgiving and Christmas) at which time domestic consumption is rising as well. For other categories, the effects of domestic consumption on inventory levels are statistically insignificant. In further considering the effects on storage stocks of the various poultry meats, retail prices and the farm to wholesale price spread were included in the inventory relation. The results show inventories of roasting chickens decreasing as retail

prices increase, as anticipated; for broiler turkeys however, an increase in retail prices is associated with an increase in storage stocks. Similar results are obtained with respect to inventory changes associated with changes in the farm to wholesale price spread. Statistically insignificant results are shown between retail prices, and between the farm to wholesale price spead, in relation to stocks of the other poultry meat subclasses.

When considering the effects of inventory levels in determining net imports of the poultry meat categories, statistically significant results are obtained for all subclasses except hen turkeys. The expected relationship is negative and occurs for all poultry meat categories except broiler turkeys where an increase in net imports is associated with an increase in inventory levels. This type of behaviour on the part of importers is irrational from an economic viewpoint but should be considered in light of the inadequacies in data with respect to imports and exports of the particular poultry meat subclass being analysed. The effects of inventory levels in determining wholesale and farm prices of the poultry meats have also been evaluated. With respect to the formation of wholesale prices, the effects of inventory levels of the poultry meat subclasses are found to be statistically significant for all categories except broiler chickens. A negative relation was anticipated, but in the case of tom turkeys the results show that increases in wholesale prices are associated with

increases in stocks. At the farm level, storage stocks of the poultry meats are shown to have statistically significant negative relationships, as anticipated, for all categories except heavy chickens.

To satisfy the second objective the relationships between prices of the poultry meat subclasses at each market level have been assessed on the basis of the structure of the marketing margins. These results are summarized in Table XLIV.

TABLE XLIV

INDICES OF RESPONSIVENESS SHOWING THE EFFECTS ON THE PRICE SPREADS ASSOCIATED WITH 1 ¢/LB. CHANGES IN RETAIL PRICES

Price Spreads	Broiler Chicken	Heavy Chicken	Broiler Turkey	Hen Turkey	Tom Turkey
$\frac{\delta(P_r - P_w)}{\delta P_r}$	0.29	0.15	0.71	1.0	0.66
$\frac{\delta(P_r - P_f)}{\delta P_r}$	0.61	0.62	0.75	0.59	0.19

In Table XLIV the changes in price spreads associated with a 1 ¢/lb. change in retail prices are presented. The retail to farm price spread, conventionally called the marketing margin, shows a larger response to retail price changes for the lighter three poultry meat categories relative to the magnitude of the response in the retail to

wholesale price spreads. In the cases of hen and tom turkeys, it is interpolated that the wholesale to farm portion of the marketing margin responds negatively to changes in retail prices; that is, as retail prices increase, the spread in farm to wholesale prices decreases. This evidence suggests that prices at the wholesale level for hens and toms remain relatively constant while retail and farm prices move together.

The final objective of the thesis was to apply the model of the Canadian poultry industry, already developed and empirically analysed, to the task of making short-term monthly price predictions. These predictions are discussed, and presented in graphical form, in the preceding section. The objective of developing an acceptable prediction model is not considered to have been satisfied.

CHAPTER V

LIMITATIONS, CONCLUSIONS AND IMPLICATIONS

A. LIMITATIONS

1. Data

It is not possible to measure the extent to which inadequacies in the data set that was analysed contributed to potential detrimental effects in the results of this study. However, the extent to which data are less than ideal in several facets of the Canadian poultry meat industry can be presented. Basically, the statistical problems encountered in empirical analysis of the industry are unlikely to be resolved without improving the data set.

Ideally, an examination of the poultry meat industry should be carried on at provincial levels, and aggregated to explain the national situation. To do this, provincial data must be obtained that relate to each of the individual poultry meat subclasses at each market level. Additional consideration could be given to differentiation within a specified poultry meat subclass according to grade characteristics. For analyses of demand forces in a single province the minimum data requirement must include prices at each market level, and slaughter estimates that pertain to each poultry meat subclass. There is also a need for

assessing the volume of poultry meat products moving through inventory, and between import and export markets. As the desire for sophistication in economic analyses grows, additional statistical parameters must be added to the provincial data set such as transportation rates, contractual obligations of producers, costs of production including feed, the extent to which prices in the provinces are administered by marketing agencies and others. These parameters should all be available for weekly, monthly, quarterly, and annual periods of time.

Having outlined what may be considered to be ideal regarding statistical needs to depict the Canadian poultry meat industry, it is now possible to illustrate the extent to which current data accumulations may be less than ideal. Considering prices initially, the average retail prices for the individual poultry meat subclasses in each province are not published. Only two retail price series, representing national average retail prices for broiler chickens and hen turkeys, were obtainable. At the wholesale level data were not published prior to 1963, and price series for the individual poultry meats were not available continuously on a provincial basis thereafter. It was consequently necessary in the analysis to proxy the national average wholesale prices of the poultry meat subclass using the prices established in London, Ontario for the reporting date nearest to the end of the desired month. At the farm level continuous publication of provincial producer prices for all

categories of poultry meat has been carried on for several years with only minor changes in provincial reporting centers and the weight designations of the poultry meat categories. National average farm prices are not published; however, these prices can be derived using the provincial data.

In considering data to depict the quantities of poultry meats reaching the different market levels, the first necessary variable represents farm production. In this study farm production excluding on-farm consumption was assumed equal to the numbers of pounds of the poultry meat categories slaughtered in registered stations. It was also assumed that the percentage of total production slaughtered in registered stations remained unchanged throughout the study period. This data series has been published on an eviscerated weight basis for individual provinces and poultry meat subclasses since 1961, with some changes to the weight designations of the different categories. Prior to 1961 these quantities were published on a dressed weight basis. The quantities of the poultry meat subclasses reaching the wholesale market level are assumed to equal farm supply minus net imports and minus net inventory change for the period in question. The quantities of frozen poultry meats in storage are adequately documented at provincial levels for each of the poultry meat subclasses. The movements of poultry meats between provinces are not published, however, nor are imports or exports of the poultry meat subclasses published either provincially or nationally. In this study, net imports of the individual

poultry meats at the national level were proxied using total net imports of either chicken or turkey meat, as dictated by the analysis. Though of lesser significance, the costs of transporting poultry meats between provincial or international market sites are also not published in usable forms.

2. Autocorrelation

According to Johnston (15:1963:177), serial independence of the disturbance term is a crucial assumption of the linear regression model. This implies that successive residuals are drawn independently of previous values. Johnston (15:1963:179) discusses three consequences of autocorrelated disturbances:

1. The estimates of coefficients are unbiased but the sampling variances of these estimates may be unduly large;

2. If the usual least-squares formulas for the sampling variances of the regression coefficients are applied, a serious underestimate of these variances will be obtained. Hence the formulas for the student-t and F tests are no longer valid;

3. Inefficient predictions, i.e. predictions with needlessly large sampling variances, are obtained.

Johnston (15:1963:177) suggests that autocorrelation may result from an incorrect specification of the form of the relationship between variables. As well, autocorrelation may be due to omitted variables. When estimating structural

parameters the effects of autocorrelation remain undesirable but may be tolerated, since estimates of structural parameters remain unbiased if autocorrelation is the only statistical problem present.

An attempt to reduce levels of autocorrelation in the estimating equations has been completed. Lagged values of the dependent variable were included as independent variables in several relations and then revised empirical estimates were derived. This technique was of marginal value in eliminating autocorrelation from the relations in which it was attempted.

3. Predictability

A third limitation of the analysis is the failure to satisfy the objective of providing a model capable of making accurate predictions for the months of 1971. In this regard, the effects of autocorrelation in the models are likely to impede their predictive abilities. The degree of variation in the dependent price variables explained by variation in the independent variables (R^2) was low in some cases, ranging from 0.71 to 0.95. To eliminate these shortcomings would require further analysis. Additionally it has been suggested that conditions arising from provincial restrictions to the movement of poultry products were in operation in the Canadian poultry meat markets during 1971. Such conditions had not been in effect during the period analysed and hence could not be incorporated into the model.

4. Marketing Board Effects

While specifying the problem situation for analysis in this study it was noted that administered pricing policies were becoming increasingly prevalent in the poultry industry through the decade of the sixties. It was not directly possible in empirical analysis to measure the extent of administered pricing policies in operation in the poultry industry from 1963-1970. An indirect assessment of these effects may be possible however. It is understood that marketing boards seek to stabilize price variation in attempts to increase the stability of producer incomes. Had this been the case for the study period, then the true conceptual model, in abbreviated form, should have included a variable to account for the effects of market regulation such as:

$$P = f(Q, MB)$$

where P denotes price, Q denotes quantity demanded, and MB denotes the impact of market regulation or price stabilization existing in the poultry market. The estimates presented in the previous section were derived from models in which no attempt was made to estimate the marketing board effects, viz.:

$$P = f(Q)$$

where variables are defined as above. If the former relation (id est the true relationship) could be empirically tested, the resulting coefficient on the quantity variable, say b_1,

would be less than the estimated coefficient, referred to as b_2, since $r_{Q,MB}$ (simple correlation coefficient) exceeds zero. In applying the formula for elasticity the ratio of means remains unchanged, but the larger magnitude of the slope coefficient obtained in the relations that did not remove the effects of price stabilization policies would tend to inflate the elasticity coefficients, id est:

since $b_1 < b_2$ and elasticity $= b_i \times \bar{P}/\bar{Q}$,

then $b_1 \times \bar{P}/\bar{Q} < b_2 \times \bar{P}/\bar{Q}$.

Therefore it is argued that the unexpectedly large elasticity coefficients obtained in this study are likely the result of an estimation problem (identification) in which an important influence (the stabilizing effect of marketing boards on prices) was not adequately incorporated. This is an important estimation problem which will affect any similar analysis of regulated products. Overcoming the problem to obtain the "true" structural parameters was not achieved in this study and it is difficult to envisage a feasible approach for this type of analysis. Unfortunately the literature was of no assistance in resolving the problem; indeed, there is little indication that the problem has even been identified in earlier studies.

5. Elasticity

In deriving own-price elasticities it is necessary to compute the reciprocal of the price flexibility coefficients. Under specific assumptions, price elasticity

and price flexibility coefficients can be shown to bear a reciprocal relationship. In practise however, this relationship is expected to be affected by specification of the theoretical model, potential omissions of variables, or simultaneity within the structural equations and the resultant identification problem. Nevertheless these computations were undertaken and the results are presented in Table XLV for the retail, wholesale and farm price relations of each category of poultry meat.

TABLE XLV

AVERAGE MONTHLY ELASTICITY COEFFICIENTS DERIVED FOR EACH MARKET LEVEL

	Retail	Wholesale	Farm
Broiler chicken	-4.1861	-1.8048	- 3.7145
Heavy chicken			-29.8507
Broiler turkey		-8.0032	-21.2314
Hen turkey			-26.4309
Tom turkey		9.4625	-21.3847

From the results of studies presented in the literature review and those obtained in this analysis, several noteworthy comparisons can be drawn. These comparisons may serve in partially vindicating some of the perceived shortcomings of the analysis in this thesis by shedding further insights into the poultry industry.

For the period 1948-1959, estimates obtained by Logan and Boles (Table IX) of quarterly price flexibilities for broiler chickens at the retail level in the United States

fell in the range -0.303 to -0.365. In this study, retail monthly price flexibility for broiler chickens (Table XVII) was estimated to be -0.239. The derived price elasticities were -2.545 to -3.069 in the United States as compared to -4.186 in Canada. Conventionally, it is expected that short-term estimates of elasticity coefficients exceed their longer term counterparts. At the farm level in the United States through the period 1953-1963, Farris and Darley (Table X) estimated monthly price elasticities of broiler chicken in the range -0.96 to -1.36. In this study farm price elasticity of broiler chickens was computed from the price flexibility coefficient (Table XXXIV) to be -3.715.

Additional comparisons can be made between the results of this study and other studies regarding turkey meats. For the period 1961-1967 Matthews derived estimates of monthly farm level price flexibilities (Table XI) for each category of turkey. For broiler, hen, and tom turkey categories, monthly price flexibilities during the January to July period were estimated to be -0.07, -0.04, and -0.14 respectively. Estimates of monthly farm level price flexibility coefficients obtained in this study (Tables XXXVI, XXXVII, XXXVIII) for the same respective turkey meat categories were -0.05, -0.04, and -0.05.

Even though comparisons between results in this study and the results presented in the studies reviewed, may reveal similarities in the magnitudes of some elasticity and price flexibility coefficients, equally as many

dissimilarities could be presented. It was noted earlier that the results presented in the literature review respecting price elasticities provided inconclusive evidence that the poultry meat categories were either elastic or inelastic in nature. The results derived in this study have potential deficiencies as well. Inability to account for the price stabilizing effects of marketing boards may have biased estimates of elasticity coefficients. Incorrect specification of the form of mathematical relationships thought to prevail in the poultry meats industry may have contributed to the autocorrelation problems. Nevertheless, it has been confirmed that an analytical problem impeding completely accurate estimations of structural parameters exists in the poultry industry. In general, the results of this thesis support the contention that demands for poultry meats are highly elastic in the short-term. Further analyses of poultry meats should be directed at reconciling the identification and estimation problems.

6. Complementarity

Throughout the presentation of results in Chapter IV, several instances of complementarity between the poultry meat subclasses and beef were noted. Evidence of such a relationship first appeared between hen turkey prices and beef prices at the retail level. In evaluating the inventory relationships, instances were noted wherein increases in inventories of the poultry meats were associated

with increases in retail beef and/or pork prices (Tables XXIV-XXVIII). At the wholesale level the effects of beef prices in the wholesale price relations were revealed to denote complementarity for hen and tom turkey meats. As well, insignificant but negative relationships were obtained between beef prices and wholesale prices of broiler and roasting chickens. A statistically significant complementary relationship was found between wholesale prices of tom turkeys and broiler chickens. Finally, at the farm price level, statistically significant complementary price relationships were found to exist between heavy chickens and hen turkeys, and between tom turkeys and pork.

Unfortunately, the lack of consistency in relationships between the poultry meats and beef was not carried to the farm price level. At one point in the several stages of empirical analysis, the possibility of excluding beef from consideration as a substitute (or complementary) commodity to poultry meat was seriously considered due to limited statistical significance and varying degrees of economic credibility. Subsequently, this effect was not estimated at the farm level. In retrospect, the exclusion of the beef price variable at this market level is a notable shortcoming of the analysis.

The evidence obtained in this analysis to support the hypothesis that poultry meats and beef are substitute (or complementary) commodities is limited. Some instances were found in which beef (pork and some poultry meat

subclasses) prices behaved in a manner depicting complementarity with poultry meats. The study by Yankowski (30:1970), reviewed in the literature, indicated that both beef and pork meats at the retail level competed in a complementary fashion with poultry meats but statistical significance was not achieved for this relationship.

Before concluding that the results are evidence of complementarity between beef and poultry meats, the seasonalities in production and traditional consumption patterns for the poultry meat subclasses should be given consideration. Complementarity describes commodities whose prices move in the same direction. It is plausible that prices of poultry meats and beef may move in such a pattern during parts of the year while still having a substitute relationship. In effect this is further evidence of the identification problems alluded to earlier. Consequently the results showing complementarity between poultry meat subclasses taken individually, or between poultry meats and red meats must be considered inconclusive.

A final limitation of this study is with respect to the choice of monthly time periods for taking observations. The choices of lengths for the production periods of the various poultry meat subclasses was largely arbitrary, but nevertheless related to the production cycles and maturation periods of the poultry categories insofar as monthly data would permit. With larger birds, such as hen and tom turkeys, the production period might be more closely

approximated using annual data. Attempts at analysing the industry using annual data however, were constrained by a lack of historical data covering a period of sufficient length to permit statistically viable results to be obtained. Attempts at analysing the poultry industry using quarterly data are currently underway.[1/]

B. CONCLUSIONS AND IMPLICATIONS

The discussion of limitations in the previous section offered insights to the types of conclusions that this study can support. Some basic weaknesses have prevailed throughout the analysis and further analyses would be required in order to eliminate these. In areas where data restrictions have been a limiting factor it is concluded that Statistics Canada, Canada Department of Agriculture and the interested segments of the poultry industry must attempt to remove the weaknesses cited. In particular, data on retail prices of the poultry meat subclasses should be extended to include all categories; and better account must be made of interprovincial and international trade patterns.

In order to enhance decision-making and strategies for market regulation in the poultry industry, models such as have been developed in this thesis, should be refined to

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[1/] The study referred to is one component of a current analysis of the Canadian meats industry being undertaken by Drs. W. J. Craddock and R. M. A. Loyns at the University of Manitoba.

remove autocorrelation problems and to improve predictive abilities, consequently improving the information base being used in the industry. The inconclusive results with respect to substitute or complementary relationships between poultry and red meats must also be reconciled and re-analysed. In this regard further studies of the Canadian meats industry are being conducted at the University of Manitoba by Dr. W. J. Craddock and Dr. R. M. A. Loyns. It is concluded that the markets for poultry meat will continue to be subjected to varying pressures from other competing meats.

From the results of analysis in this thesis, price elasticity coefficients have been derived that appear unexpectedly large in magnitude. Although suggestions have been made to rationalize the unexpected size it is concluded that short-term demands for poultry meats are highly elastic. Support for this conclusion has also been obtained from other studies reviewed in the literature.

It was determined from analysis of cross-section data that income elasticities for poultry meats are small in magnitude; in the case of turkeys no income effect was observed. The small magnitude of income elasticity coefficients for chicken and turkey meats implies that rising consumer incomes can not be expected to induce a noticeable amount of growth in the consumption of poultry. Furthermore it can be noted from the data that per capita consumption of the poultry meat subclasses increased markedly during the period analysed. This implies that changes in tastes and

preferences of consumers are not constant over time. During the period analysed, prices were falling in both absolute and real values. Consideration of these conditions in force in the market during the period of analysis lead directly to the conclusion that demands will be elastic in nature, i.e. that the absolute magnitude of the elasticity coefficients exceed 1.0. Therefore it is important to note that, as a strategy for market regulation, inter-month transfers of poultry meat products are revenue increasing. In addition, the execution of production controls through quotas deserves careful attention.

After evaluating the effects on the Canadian poultry meat markets, arising from conditions in the United States poultry meat markets, it is concluded that the current level of tariffs is effective in insulating the markets in the two countries. At least, it can be concluded that monthly price movements in each country are independent from each other.

In drawing final conclusions from this study there are three areas to which further research should be addressed. One area, already considered in some detail by Longmuir (18:1972), is with regards to regulation and control of farm production and of inventory. Much information has been gathered, and detailed in this thesis, to document the seasonal patterns of demand, and the variations in elasticities associated with months of the year and between the poultry meat subclasses. These factors, when placed in perspective, contain useful implications to consider in

outlining strategies for regulated marketing.

A second area, worthy of additional research but currently lacking in regards to data, is the study of demand elasticities with respect to expenditures on the poultry meat subclasses. If data about expenditures on the various meats were used in place of consumption figures, information could be derived showing quality effects. The quality effects, as perceived by consumers, can then be useful information in explaining individual preferences for the poultry meat categories. Ideally, the five poultry meat categories should be expanded to take account of differentiations in choice arising from the grading process with resulting effects to the preferences of consumers. However, until primary data are collected which record characteristics of sales by quality, this type of study cannot be conducted using an econometric method.

Finally, the marketing margins for each poultry meat category warrant additional study. It has been noted that the degrees of administered pricing which prevails in the Canadian poultry industry is increasing. In this regard, primary producers and final consumers are becoming more and more insulated from each other. The means whereby final demands are derived through the marketing channels to producers are reflected in marketing charges. Consequently the formation and behaviour of the marketing margins should be understood if the industry wishes to be effective in administering prices.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Auer, L. "Urban Consumer-Incomes and Food Expenditures." Paper presented to the fourth annual meeting of the Canadian Economics Association, June 3, 1970, Winnipeg, Manitoba.

2. Bluestone, H., and Rojko, A. S. "Forecasting Farm Turkey Prices In and Out of the Main Marketing Period," Agricultural Economics Research, XVIII, 2 (April, 1966), 43-51.

3. Brandow, G. E. Interrelations Among Demands for Farm Products and Implications for Control of Market Supply. The Pennsylvania State University, College of Agriculture, Agricultural Experiment Station, Bulletin No. 680. August, 1961.

4. Bressler, Jr., R. G., and King, R. A. Markets, Prices, and Interregional Trade. New York: John Wiley and Sons, Inc., 1970.

5. Emmery, M. K. The Outlook for Poultry Meat in Canada to 1980. Economics Branch, Canada Department of Agriculture, Ottawa, December, 1967.

6. Ezekiel, M., and Fox, K. A. Methods of Correlation and Regression Analysis. New York: John Wiley and Sons, Inc., 1959.

7. Farris, Paul L., and Darley, Richard D. "Monthly Price Quantity Relations for Broilers at the Farm Level," Journal of Farm Economics, XLVI, 3 (1964), 849-856.

8. Foote, Richard J. Analytical Tools for Studying Demand and Price Structures. United States Department of Agriculture, Agriculture Handbook No. 146. August, 1958.

9. Fox, K. A. The Analysis of Demand for Farm Products. United States Department of Agriculture, Technical Bulletin No. 1081. 1953.

10. Friedman, Milton Essays in Positive Economics. Part I,

11. George, P. S., and King, G. A. Consumer Demand for Food Commodities in the United States with Projections for 1980. Giannini Foundation of Agricultural Economics, Monograph No. 26. March, 1971.

12. Haavelmo, T. "The Statistical Implications of a System of Simultaneous Equations," Econometrica, XI, 1943.

13. Henderson, James M., and Richard E. Quandt. Microeconomic Theory. New York, Toronto, London: McGraw-Hill Book Company, 1958.

14. Hill, J. T. "Structure and Concentration in the Canadian Poultry Meat Industry", Canadian Farm Economics. I, 2, Economics Branch, Canada Department of Agriculture, 1966.

15. Johnston, J. Econometric Methods. New York: McGraw-Hill Book Company, 1963.

16. Lee, Ivan M. "Regression and Other Tools for Price Analysis", Pricing as a Problem for Marketing Research. Proceedings, Western Agricultural Economic Research Council, University of California, Berkeley, 1963.

17. Logan, Samuel H., and Boles,James N. "Quarterly Fluctuations in Retail Prices of Meat," Journal of Farm Economics. XLIV, 4, 1962.

18. Longmuir, N. L. "Aspects of Regulated Marketing for Agricultural Products: The Case of Poultry Meat" Unpublished Master's Dissertation, University of Manitoba, 1972.

19. Matthews, C. B. "An Econometric Model for Ontario Turkey Prices." Unpublished Master's Dissertation, University of Guelph, 1968.

20. Nagel, E. "Assumptions in Economic Theory", American Economic Review. May, 1963.

21. Salmon, W. C. Logic. Englewood Cliffs, New Jersey: Prentice-Hall Incorporated, 1963.

22. Samuelson, P. A. Foundations of Economic Analysis. New York: Atheneum,1967.

23. Shepherd, Geoffrey S. Agricultural Price Analysis. Ames, Iowa State University Press, 1968.

24. Soliman, M. A. Quarterly Econometric Model of the Turkey Industry in the United States. University of Minnesota, Agricultural Experiment Station, Technical Bulletin 275, 1970.

25. Stanton, B. F. "Seasonal Demand for Beef, Pork, and Broilers," Agricultural Economics Research, XIII,1 (January, 1961), 1-14.

26. Tomek, W. G. "Using Zero-One Variables with Time Series Data in Regression Equations," Journal of Farm Economics, XLV, (1963), 814-822.

27. Waugh, Frederick V. Demand and Price Analysis. United States Department of Agriculture, Technical Bulletin No. 1316. 1964.

28. Wold, Herman, and Jureen, Lars. Demand Analysis. New York: John Wiley and Sons, Inc., 1953.

29. Wood, J. W. "Some Aspects of the Marketing and Pricing of Broilers in Ontario," Canadian Journal of Farm Economics, XI, 1 (1963), 49-59.

30. Yankowski, Z. "The Intermediate- and Long-Term Market Outlook for Beef," Canadian Farm Economics, V, 3 (August, 1970), 1-10.

31. Yeh, M. H. "Statistical Estimation" Winnipeg: Department of Agricultural Economics, University of Manitoba, 1964. (Mimeographed).