SOME MEASUREMENTS OF CONSUMER DEMAND FOR MEATS

Thesis for the Degree of Ph. D.

MICHIGAN STATE COLLEGE

Harold M. Riley

1954

This is to certify that the

thesis entitled

Some Measurements of Consumer Demand for Meats

presented by

Harold M. Riley

has been accepted towards fulfillment
of the requirements for

Doctor of Philosophy degree in Agricultural Economics

G. W. Quackenbush

Date July 29,

SOME MEASUREMENTS OF CONSUMER

DEMAND FOR MEATS

by

Harold M. Riley

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan
State College of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1954

Approved Gerald G. Quackenbush

Harold M. Riley

ABSTRACT

This study was an attempt to measure consumer responses to changes in prices for different kinds of meat. Previous demand studies of this nature have been based almost entirely upon annual average prices and quantities for broad groups of meats for the entire United States. In most cases the period for these studies has been the interval between World Wars I and II. It was believed that demand relationships based on more recent observations and for periods of time shorter than one year would be a useful supplement to these earlier studies.

The basic data for this study were the weekly food purchase records of the M.S.C. Consumer Panel. This panel is composed of approximately 250 families selected so as to be representative of the city of Lansing, Michigan. Weekly average prices and quantities purchased per family were available for a two year period, July 1951-June 1953. Fortunately this was a period of substantial price changes for both beef and pork.

Single equation demand models were fitted to the data using least squares regression techniques. The basic equations expressed the quantity purchased of one kind of meat

as a function of the price of that meat group, the prices of competing meats, and a temperature variable.

It was found that the price elasticity of demand for both beef and pork were near unity at their respective mean values. Beef prices seemed to have a significant influence on pork purchases, however, pork prices had a somewhat weaker influence on beef purchases for the period studied. The prices of sausage, poultry or fish did not have a significant influence on either beef or pork purchases. The price elasticity of demand for sausage meats was not significantly different from zero while poultry and fish appeared to have elastic demands. The price elasticity of demand for <u>all meat</u> was about -.7 at the mean value of price and quantity.

Temperature was significantly related to meat consumption during the warm season of the year. An increase of 10 degrees in the weekly average of mean daily temperatures depressed purchases of pork, beef, and <u>all meat</u> by approximately 3 percent.

A preliminary analysis of demand for retail cuts of meats indicated that the price elasticity of demand for beef steak was highly elastic. The price elasticity of demand for beef roasts, ham and pork chops were slightly elastic while the demand for ground beef and bacon was slightly inelastic.

SOME MEASUREMENTS OF CONSUMER

DEMAND FOR MEATS

by

Harold M. Riley

A THESIS

Submitted to the School of Graduate Studies of Michigan
State College of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1954

6/19/57
G 1512

ACKNOWLEDGEMENTS

The author wishes to express a special debt of gratitude to Dr. G. G. Quackenbush for his helpful and patient counsel in supervising this investigation and in the preparation of this manuscript. Special thanks are also extended to Dr. J.D. Shaffer who provided invaluable assistance in the planning of IBM tabulations and for his constructive criticism of results at various stages in the study. Acknowledgement for advice on the more technical aspects of this analysis is due Dr. L.L. Boger. Appreciation is also expressed to Dr. R. C. Kramer and Dr. B. C. French for helpful suggestions as the study progressed. Sincere thanks are offered to the clerical staff in the Department of Agricultural Economics who carried on the laborious task of statistical analysis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The M.S.C. Consumer Panel

This dissertation is a report on an analysis of consumer demand for meats. The principal source of data was detailed food purchase records provided by some 250 families in Lansing, Michigan. This group of families will hereinafter be referred to as the "M. S.C. Consumer Panel." Each week these families record their food purchases in a diary provided by the Department of Agricultural Economics of Michigan State College.[1] (See appendix). Information reported includes the price, quantity and total expenditure for each food item purchased. Additional information is also reported on current income, size of family and number of meals served.

The M.S.C. Consumer Panel has operated since March 1951. The research project that supports the panel was originally set up to continue over a period of ten years. The data

---

[1] The organization and operation of the M.S.C. Consumer Panel is under the direction of Dr. G. G. Quackenbush and Dr. J. D. Shaffer.

available for this study covers 104 weeks beginning in July 1951 and ending in June 1953. During this period substantial fluctuations occurred in retail prices of beef and pork, thus making it feasible to study consumer adjustments to price changes.

The panel is unique in that it provides a complete record of each individual family's food purchases on a weekly basis over an extended period. Most of the previous demand studies have been limited to the use of two principal types of data. One type is annual time series of price and quantity estimates for broad groups of commodities for the entire United States. The other main source of data has been a series of cross-sectional studies where food purchase data for a given week are obtained from a sample of families residing in selected localities.

Previous Studies

Most of the empirical studies designed to measure price and cross elasticities of demand for meats have been based on annual time series data for the interval between World Wars I and II. In general, the results of these studies have failed to provide a reliable basis for forecasting price-quantity relationships during the post World War II period . This difficulty can be attributed, in part, to the rapid changes in the economic and social environment during the past thirty years. At present the number of annual observations are too few to support a rigorous demand study limited to the post-war period. The usefulness of demand elasticities derived from annual observations is also limited by the high degree of aggregation which goes into the raw data. The demand characteristics for more narrowly defined commodity groups and for periods shorter than one year should be of greater usefulness to food merchandisers.

Cross-sectional studies have provided useful information relating meat consumption to various social and economic characteristics of the families interviewed. Difficulties have been encountered, however, in attempting to predict the effects of changing income levels on meat consumption based on results of these studies.

The data from the M.S.C. Consumer Panel can be analyzed both as a time series and on a cross-sectional basis. Due to its flexibility, both as to time periods studied and degree of aggregation of commodities, the panel data should yield some worthwhile measurements of demand. These measurements will supplement those already available from the studies based on annual time series or cross-sectional survey data.

Objectives of the Study

The primary objective of this study was to obtain some useful measurements of changes in consumer meat purchases associated with changes in retail prices. In more traditional terminology the objectives were to obtain empirical measurements of the price and cross elasticities of demand for different kinds of meat. Emphasis was placed upon the analysis of demand for beef and pork, however, demands for sausage meats, poultry and fish were also studied. Some preliminary analyses of demand for retail cuts of beef and pork were made during the later stages of the investigation.

A secondary objective of this study was to develop procedures for analyzing panel data. Since this was one of the first demand studies based on information from the M.S.C. Consumer Panel much was to be learned about the peculiarities of processing this type of data. Due to the large number of available observations, extensive use of IBM equipment was necessary. This was followed by graphical examination of the data to determine the nature of the relationships as well as some of the disturbances present. Several single equation demand models were formulated and fitted mathematically using the traditional least squares regression procedures.

Usefulness of Results

Meat is one of the most important food items produced and consumed in this country. During 1953 farmers obtained 29 percent of their total cash receipts from the sale of meat animals.[2] The processing and wholesale distribution of meat is the principal activity for some 1160 commercial meat packers.[3] In addition, there are approximately 2000 small slaughterers and a large number of specialized meat wholesalers who derive a major portion of their income from the handling of meats. Between the packer and the consumer there are 362,000 [4] retail food stores in which the meat department accounts for 25 to 30 percent of total store sales. Restaurants and institutions are also important users of meat. During 1953 consumers spent approximately 26 percent of their disposable income for food.[5] Meat purchases made up approximately one-fourth of the total food bill.

---

[2] Agr. Mkt. Ser., U.S. Dept. of Agr., The Farm Income Situation, March 1954, p.9.

[3] Bur. of Agr. Econ., U.S.Dept. of Agr., The Livestock and Meat Situation, September,1950, p.12.

[4] The Progressive Grocer, March, 1954, p.46.

[5] Agr. Mkt. Ser., U.S. Dept. of Agr., The Marketing and Transportation Situation, February, 1954, p.40.

The pricing and merchandising of meat is a complex procedure. Meat supplies fluctuate from week to week, seasonally and cyclically. A large proportion of the meat is sold as "fresh" meat. Due to its perishability, it is extremely important that meat prices, at all stages of distribution, are adjusted to facilitate the smooth and rapid flow of the product into the hands of consumers. Merchandisers must also consider changes in consumer demand due to weather, holidays or shifts in purchasing power. On the less perishable meat items merchandisers must also make decisions with regard to storage policy.

It is hoped that this study will provide information that will be useful to the meat trade in their pricing and merchandising operations. A comprehensive knowledge of the demand characteristics for different kinds and cuts of meat appears to be essential if merchandisers are to price efficiently and profitably. Some merchandisers may gain sufficient knowledge through experience to do an effective pricing job. However, it is believed that there are many others who have an inadequate knowledge of the basic demand relationships and therefore they must depend upon crude rules of thumb or over-simplified tables in setting their prices.[6]

---

[6] Meat Merchandising, Inc., Master Meat Pricer, 105 South Ninth Street, St.Louis 2, Missouri. 1949

Information on price and cross elasticities of demand for meats should be of use to those charged with public responsibility for the formulation and administration of agricultural programs. Reliable elasticities are relevant to considerations such as how best to carry on a government purchase program to support the price of beef or pork. Questions may also arise with regard to appraising the effects of policies which would encourage or discourage livestock production. Policy decisions with regard to import and export restrictions on meats might also be affected by information on elasticities of demand.

Trade groups organized to promote the sale of meat may find the results of this study useful in planning their programs. During 1953, the National Livestock and Meat Board spent over $500,000 in promoting the sale of meat. Funds were provided by assessments paid by farmers and marketing agencies. Promotional programs of a similar nature are now being initiated in individual states. Measurements of consumer demand for meats as an aggregate, as well as for different kinds and cuts of meats, should be relevant in deciding what meat items to promote and also in appraising the effectiveness of the promotion programs.

CHAPTER II

THEORY AND MEASUREMENT OF DEMAND FOR INTERRELATED COMMODITIES

Introduction

Most empirical investigations are guided by a body of theoretical concepts which influence the researcher to select certain hypotheses for testing. In this study the theory of consumer demand for interrelated commodities appeared to be relevant. Unfortunately, many of the demand concepts are expressed in terms of "marginal utilities" and "marginal rates of substitution." These concepts provide powerful tools for a subjective analysis of demand, but their empirical measurement has proven to be most difficult.[1] Perhaps an even more serious criticism of existing demand theories is the inadequate development of concepts which explain consumer behavior under non-static and imperfectly competitive conditions.

---

[1] For a recent statement on the problem of measuring demand, see the article by Irving Morrissett, "Some Recent Uses of the Elasticity of Substitution--A Survey," Econometrica, 21:41-62, January 1953. See also Frederick Mosteller and Philip Nogee, "An Experimental Measurement of Utility," Journal of Pol. Econ., 59:371-404, 1951 ; Stephen W. Rousseas and A. G. Hart, "Experimental Verification of a Composite Indifference Map," Journal of Pol. Econ., 59:288-318, 1951.

This chapter is divided into two parts. The first is a brief statement of some of the theoretical demand concepts relevant to this study. Little or no attempt was made to develop new theories since the primary purpose of this dissertation was that of measurement. The second part of the chapter will deal with some of the measurement problems.

Basic Concepts of Demand Theory

Underlying assumptions. Most of our demand theories have been developed within a framework of a perfectly competitive, static system. The principal assumptions of this system, which are most directly related to a study of demand, are as follows:

(1) Individuals possess perfect knowledge.
(2) Preference patterns are fixed.
(3) Commodities are perfectly homogeneous.
(4) Individuals are motivated to maximize their satisfactions within the limitations of their real incomes (rational behavior).
(5) The distribution of real income is fixed.
(6) No individual seller is large enough to appreciably affect the price of a commodity.
(7) Population is fixed.
(8) Technology is fixed.
(9) Government and other institutions are fixed so as to permit individuals freedom of choice.

Definition of demand. Before progressing further with a statement of demand theory, the term "demand" should be defined. As used in this study, demand will be considered to be a schedule of the quantities of a commodity that an individual (or group of individuals) is willing to buy at all possible prices, other things remaining the same.[2]

This definition of demand is essentially the one developed by Marshall.[3] Considerable debate has taken place over the interpretation of the "other things remaining the same" clause in the definition.[4] This is often referred to as the <u>ceterus paribus</u> condition. In this study the "other things" considered to be held constant are as follows: (1) tastes and preferences of the group of purchasers considered; (2) their real income; (3) the price of every other "related" commodity.

Law of demand. Traditional demand theory usually begins with individual demand and proceeds, through an aggregation process, to market demand. The inverse relationship between price and quantity, which is typical of most individual demand schedules, is rationalized in terms of diminishing marginal utility for additional units of a commodity. Marshall formalized this relationship in his classic "law" of demand which states, "the greater the amount to be sold, the smaller the

---

[2] For alternative definitions of demand see Victor E. Smith, "The Classicists Use of Demand," Jour. of Pol.Econ., 59:242-57, 1951.

[3] Alfred Marshall, Principles of Economics, 8th ed. Macmillan, London, p.100 and p.109.

[4] Milton Friedman, "The Marshallian Demand Curve," Jour. of Pol. Econ., 57:463-495, 1949.

price at which it is offered in order that it may find purchasers" or, in other words, the amount demanded increases with a fall in price and diminishes with a rise in price.[5] Exceptions to this law have been recognized in the cases of "inferior" goods and prestige items.

Equilibrium conditions. It is assumed that the individuals can maximize their total satisfactions by adjusting their holdings of consumer goods until the ratio of the marginal utility to the price for each good is equal to similar ratios for all other commodities.[6]

$$\frac{MUa}{Pa} = \frac{MUb}{Pb} = , \text{-------}, = \frac{MUn}{Pn}$$

For the individual purchaser, prices are assumed as fixed.

A market demand schedule represents an aggregation of the demand schedules for all individuals in the market. A market equilibrium exists when all individuals have adjusted their holdings of commodities so as to fulfill the equilibrium condition stated above and when prices have adjusted so that the sum of the quantities, which all individuals wish to hold, is just equal to total stocks. In simpler terminology, supply is equal to demand.[7]

---

[5] Marshall, op.cit., p.96.

[6] Knut Wicksell, Lectures on Political Economy, Routledge & Kegan Paul Ltd., London, 1934, pp.47-48.

[7] Ibid., p.53

Demand for related goods. Classical demand theory has been extended by Pareto, Hicks and others to provide a useful explanation of demand for related commodities.[8] A system of indifference curves was used as a geometric illustration of the theoretical relationships (Figure I).

Figure I shows the general case with an indifference map for two related commodities, X and Y. Each indifference curve shows all the combinations of X and Y to which the individual is indifferent. Starting at the origin, O, moving upward and to the right, each indifference curve represents a higher level of total satisfaction. According to Pareto it is not essential to be able to attach a cardinal measurement to each curve.[9] It is sufficient merely to know the one curve represents a higher or lower level of total satisfaction as compared to another curve.

In arriving at an equilibrium position the individual adjusts his holdings of X and Y until he reaches the highest indifference curve attainable with his limited income. Assume that Y is money and an individual has OC units. The market rate of exchange (price) is such that OC units of money are equal in value to OI units of X. An equilibrium is reached by exchanging AC units of money for CG units of commodity X.

---

[8] J.R.Hicks, Value and Capital, 2nd ed. Oxford Univ. Press, London, 1946, Part I.

[9] Marshall's development of individual demand implies measureability of utility.

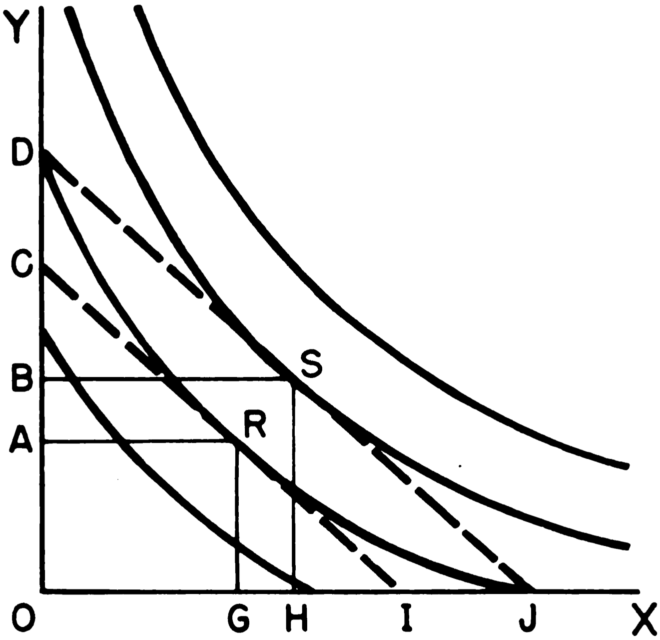


Fig. Ia

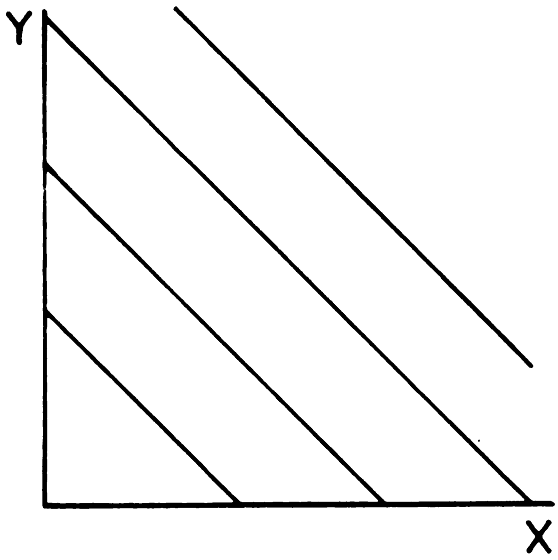


Fig. Ib

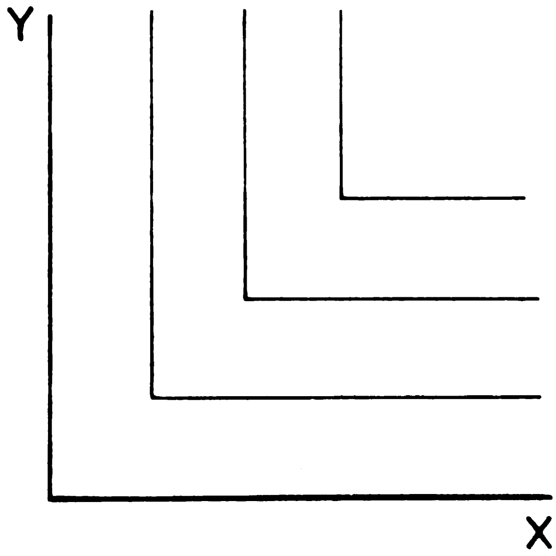


Fig. Ic

Figure I. Indifference maps for related commodities.

Point R represents the highest level of satisfaction attainable from income OC. Any other combination of X and Y will place the individual on a lower indifference curve. If his income should rise to OD, the new equilibrium position is represented by point S.

Pareto distinguished between two limiting cases of related commodities. Figure Ib represents the indifference map for two commodities which are perfect substitutes for one another. In this case the exchange ratio between the two commodities must remain equal to the slope of the indifference curve. Any deviation in the exchange ratio will result in a complete shift to the purchase of the cheaper commodity.

Figure Ic illustrates an indifference map for two commodities which are perfect complements. Shifts in the ratio of exchange between X and Y will not change the relative quantities purchased. This means that a rise in the price of X relative to Y will not alter the proportions in which the two commodities are purchased.

Figure Ia illustrates a more general case with two commodities which are related but not as perfect substitutes or complements.

According to Pareto's definition, Y is competitive with X (or is a substitute for X) if an increase in the supply of X (Y constant) lowers the marginal utility of Y. Y is a complementary with X if an increase in the supply of X (Y constant) raises the marginal utility of Y.[10]

Hicks objected strongly to Pareto's definitions of complementarity and substitutability on the grounds that they have no preciseness unless utility can be measured in cardinal terms. Hicks suggests that one way to avoid this difficulty is to abandon the marginal utility concept and replace it with a new concept, "marginal rate of substitution," hereinafter referred to as MRS. By definition the MRS of X for Y is the quantity of Y which will just compensate the consumer for the loss of a marginal unit of X.[11] Geometrically the MRS is represented by the slope of the indifference curve. At the equilibrium point R, in Figure Ia, the slope of the indifference curve is equal to the slope of the price line, CI. This equilibrium is also described by the condition that the MRS of Y for X is equal to the ratio of the price of X to the price of Y.

Hicks' definitions of substitutability and complementarity are intuitively quite precise. The definitions are as follows:[12]

> "Y is a substitute for X if the MRS of Y for money is diminished when X is substituted for money in such a way as to leave the consumer no better off than before."

---

[10] Ibid. p.43

[11] Ibid. p.20

[12] Ibid. p.44

> "Y is complementary with X if the MRS of Y for money is increased when X is substituted for money in such a way as to leave the consumer no better off than before."

These definitions are quite similar to those stated by Pareto with one major exception. Hicks specifies that the consumer be "left no better off than before." While intuitively clear this condition has rendered the definitions empirically unworkable.

Income effect. Perhaps one of Hicks' more useful contributions was his careful separation of the effects of a commodity price change into an "income effect" and a "substitution effect."[13]

If the price of a commodity X falls in relation to Y, the adjustment to the new equilibrium occurs as shown in Figure II. The original equilibrium was at point R. When the price of X declines, as shown by the new price line AI, the new equilibrium is at point T. The adjustment to this equilibrium was the combination of movement along an income-consumption path from R to S and then down the indifference curve to point T. The first portion of this adjustment was the effect of a change in income brought about by the reduction in the price of X. The substitution effect was the movement down the indifference curve from S to T.[14] For

---

13 Ibid. p.29.

14 Marshall's demand function represents only the substitution effects of price changes. The income effects are omitted by assuming a constant marginal utility for money. Marshall argues that for most consumer goods the income effect is too small to be of importance.

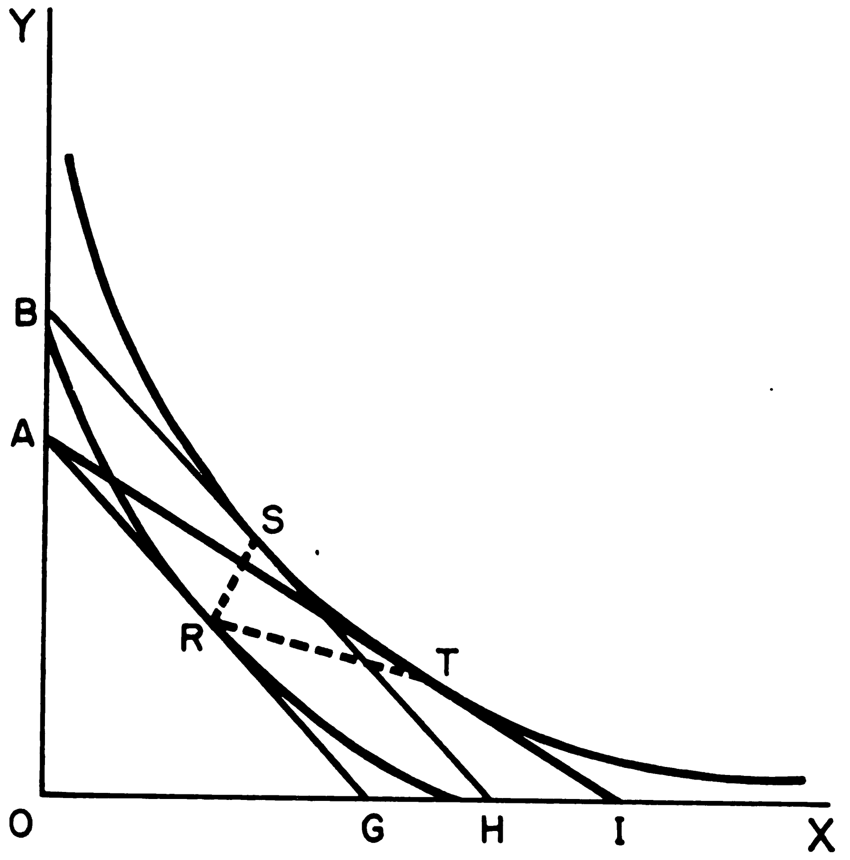


Figure II. Income and substitution effects of a price change for related commotidies.

inferior goods the income effect will be in the opposite direction from the substitution effect. For superior goods the income effect reinforces the substitution effect.

This differentiation of the effects of a price change appears to be relevant to a study of demand for meats where certain items apparently are inferior goods for a large segment of population. Assuming substitution is the dominant relationship between different kinds and cuts of meat, what is the effect of a fall in the price of one item, e.g. beef, on the demand for a competitive item, pork? If the two items are mildly substitutable a fall in the price of beef would have a very slight effect on the demand for pork since the income and substitution effects tend to cancel out. If pork were an inferior good, demand would be likely to contract. If pork and beef were highly substitutable, a decline in the price of beef would depress the demand for pork due to the dominance of the substitution effect over the income effect.

Recent theoretical concepts. Thus far the demand theories discussed have been limited to those formulated under the assumptions of a perfectly competitive, static system. These theories provide a useful framework for some empirical demand studies. Nevertheless, it is recognized that the underlying assumptions do not adequately represent reality. There have been several attempts to develop new theories based on more realistic assumptions. These contributions have not been well integrated. Consequently, only a brief recognition of some of the principal ideas will be presented in this dissertation.

Norris has developed one of the more significant contributions in attempting to present a theory of consumer's demand based on conditions of imperfect competition.[15] Product differentiation and non-price competition are recognized as conditions essential to a realistic explanation of the activities in the consumer market. It is assumed that most goods are presented to the consumer in clusters of competing substitutes due to the existence of brands and grades. The dominant role of the seller in influencing shifts in demand is also pointed out. An argument is advanced that the process of comparing prices and weighing them against expected marginal satisfactions is a disagreeable process. Consequently consumers may give little consideration to the purchase of "petty goods" which are inexpensive in relation to total consumption expenditures. Norris cautioned against the view that the consumer at any time actually brings all of his consumption pattern into any kind of equilibrium.

---

[15] Ruby Turner Norris, The Theory of Consumer's Demand, 2d ed. Yale Univ. Press, New Haven, 1952.

Some recent publications by Katona[16], Bilkey[17] and others suggest that the psychologists have much to contribute toward a more realistic and comprehensive understanding of consumer buying behavior. This approach to demand analysis recognizes the dynamic nature of the decision making process involved in consumer purchasing. The underlying motives and attitudes of consumers are studied and related to buying behavior. Changes in behavior are explained in terms of the learning process through which consumers acquire new attitudes and motives.

In this study of demand for meats traditional theories have been used to provide the basic framework for analysis. Nevertheless, consideration of some of the newer demand concepts have influenced the choice of relevant variables and the interpretation of statistical results.

Measurement of Demand

General. Empirical studies of demand have centered around the estimation of functional relationships between

---

16 George Katona, Psychological Analysis of Economic Behavior, McGraw-Hill, New York, 1951

17 Warren Bilkey, "The Vector Hypothesis of Consumer Behavior," Jour. of Mkt., 16: 137-151, 1951.

prices, incomes and quantities purchased of different commodities. Due to limitations of available data and the inadequacies of statistical procedures the accuracy of some of the estimated demand parameters have been subject to criticism. As improved data and statistical procedures are developed more reliable measurements of demand can be expected. In this section the various elasticity concepts will be defined and the methods of measurements will be discussed briefly as a background for the empirical work which makes up the main body of this dissertation.

Price elasticity. Price elasticity of demand is a term used to express the functional relationship between the prices and quantities purchased of a given commodity. "The elasticity (or responsiveness) of demand in a market is great or small according as the amount demanded increases much or little for a given fall in price, and diminishes much or little for a given rise in price."[18]

The mathematical definition of price elasticity of demand is as follows:

$$E = \frac{\frac{dq}{q}}{\frac{dp}{p}} = \frac{dq}{dp} \cdot \frac{p}{q}$$

where p is the price and q is the quantity of the studied commodity. Price elasticity is a measurement of the per-

---

[18] Marshall, op.cit., pp.102-103.

centage change in quantity purchased associated with a one percent change in price.

Price elasticity will ordinarily be negative for most commodities due to the inverse relationship between prices and quantities purchased. A useful classification of price elasticities is based on the changes in total revenue as the price of a commodity moves up or down (Table 1).

Table 1.

PRICE ELASTICITY AS RELATED TO TOTAL REVENUE[19]

Elasticity of Demand	Effect on Total Revenue	
	Price Rise	Price Decline
Inelastic, <1	TR rises	TR declines
Unit elasticity, 1	TR unchanged	TR unchanged
Elastic, >1	TR declines	TR rises

Cross elasticity. Cross elasticity of demand measures the percentage change in quantity purchased of one commodity associated with a one percent change in the price of a second commodity. When studying the demand for interrelated items, such as different kinds of meats, this demand measurement becomes important. The mathematical formula for a cross elas-

[19] George J. Stigler, The Theory of Price, rev.ed., Macmillan, New York, 1952, p.37.

ticity is as follows:

$$E = \frac{\frac{dq_1}{q_1}}{\frac{dp_2}{p_2}} = \frac{dq_1}{dp_2} \cdot \frac{p_2}{q_1}$$

In this equation q_1 is the quantity of the first commodity and p_2 is the price of a related commodity. When two goods are competitive the cross elasticity will be positive. Conversely, if the goods are complementary the cross elasticity will be negative. In this study the regression coefficients will indicate the relationships between different kinds of meat.

Income elasticities. The term "income elasticities" refers to two separate groups of empirical estimates. The first group of elasticities is derived from market data with observations extending over a period of time. Based on this type of data there are three different kinds of income elasticity.

Income-quantity elasticity is a measure of the percentage change in quantities purchased associated with a one percent change in income. Mathematically this is equivalent to this expression--

$$E = \frac{\frac{dq}{q}}{\frac{dI}{I}} = \frac{dq}{dI} \cdot \frac{I}{q}$$

where q is the quantity purchased and I is a measure of income.

Income-expenditure elasticity is a measure of the percentage change in expenditures for a commodity associated with a one percent change in income. Expressed mathematically this becomes:

$$E = \frac{\frac{dE}{E}}{\frac{dI}{I}} = \frac{dE}{dI} \cdot \frac{I}{E}$$

where E is the expenditure for the commodity and I is income.

Income-price elasticity can be defined as the percentage change in the price of a commodity associated with a one percent change in income.

$$E = \frac{\frac{dp}{p}}{\frac{dI}{I}} = \frac{dp}{dI} \cdot \frac{I}{p}$$

Due to differences in procedures used in adjusting time series data there are wide variations in estimates of income-elasticities. Most of the difficulty centers around the procedures used for deflating price and income data so as to differentiate between the effect of changes in "real income" as compared to "money income."[20]

---

[20] Elmer J. Working, "Appraising the Demand for Agricultural Output During Rearmament," Jour.Farm Econ., Vol.34, 1952, p.213.

A second group of income elasticities have been derived from cross-sectional data. The definitions of elasticities stated above are adaptable to these data. However, the interpretation of the results is somewhat different. When using cross-sectional data the income-quantity and income-expenditure elasticities represent the differences in purchasing patterns associated with different levels of family income measured at a point in time. Due to difficulties in measuring the "net" relationships between income and purchases of food items, attempts to reconcile income elasticities based on cross-sectional data with those derived from time series have been relatively unsuccessful.[21] Apparently there are many interrelated factors that affect differences in family food purchases, with income being only one of them.

Income-price elasticity is relatively unimportant in cross-sectional analysis since it represents differences in the "quality" of commodities purchased by families with different income levels.

Regression analysis. The various methods for measuring demand elasticities range from the computation of simple arc elasticities to the fitting of highly complex mathematical

---

[21] Karl A. Fox, "Factors Affecting Farm Income, Farm Prices and Food Consumption." Agr. Econ. Res., Vol. 3, 1951. pp.79-81.

models. Probably the most widely used procedure has been traditional least squares regression. In recent years considerable controversy has arisen over the applicability of the single equation methods of estimating demand parameters.[22] A system of equations approach is being developed to handle some of the estimation problems which are not adaptable to single equation methods. Disagreements still exist, however, with regard to the kinds of problems that can be handled satisfactorily with single equation methods. A complete analysis of this question is beyond the scope of this dissertation.[23]

A combination of circumstances made it desirable to use the more flexible and less expensive single equation regression procedures in this study.[24] One reason was that the

---

[22] M.A.Girshick and Trygve Haavelmo, "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Equations," Econometrica, 15:79-110, 1947.

[23] For consideration of this problem see Richard J. Foote and Karl A. Fox, Analytical Tools for Measuring Demand, Agr.Mkt.Ser., U.S.Dept.Agr., Agr.Handbook No.64, 1954. See also, Herman Wold and Lars Jureen, Demand Analysis, John Wiley, New York, 1953, Chap.II.

[24] In an unpublished Ph.D. thesis entitled, An Econometric Analysis of Demand for Eggs, Iowa State College, 1952, George G. Judge, concludes as follows: "Computations with the simultaneous equation method are quite complex and time consuming. Unless the investigator possesses a thorough knowledge of the simultaneous equations procedure and has a large amount of resources available (both monetary and physical), he will probably find a more efficient use of research resources could be made with the alternative methods even though in some cases the accuracy of the results may be questionable. Resources spent on including more variables in a single equation may, in some instances, yield more information." (p.215).

large mass of data available from the M.S.C. Consumer Panel was being processed and analyzed for the first time. It was expected that errors might be uncovered during and after the equations had been fitted. Recomputing a complicated mathematical solution to a system of equations would have been expensive and time consuming. Another reason for favoring the use of single equation models was that the relationships existing in the panel data and the peculiarities of handling weekly time series observations were not well known. It was reasoned that even if it were known to be desirable to use a system of equations procedure, such an analysis should be preceded by a rather thorough examination of the data using simpler methods.

Some of the limitations of the single equation multiple regression methods of analysis should be recognized. The assumptions of this approach are as follows:[25]

(1) The observations of the explanatory variables are not subject to errors of definition or measurement. It follows that the unexplained part of the variance of the dependent variable is due either to errors in that variable or to the influence of omitted variables.

---

[25] A. R. Prest, "Some Experiments in Demand Analysis," Review of Econ. Statistics, 31:33-49. 1949.

(2) The residual errors are not autocorrelated, being drawn independently in each time period from a stable, normal population.

(3) The equation does not form part of a set of simultaneous equations or, at least if it does, the influence of changes in these equations can be neglected.

The extent to which the equations and the data used in this study fulfilled the above assumptions can be commented on only briefly at this point. With regard to the first assumption, it is almost a certainty that some errors exist in the explanatory variables and, therefore, some of the parameters will be biased to some extent.[26] The amount of such bias is not easily determined. However, if the errors are randomly distributed the regression coefficients should be unbiased. Tests for autocorrelation of residuals can be made. If the amount of autocorrelation is large there may be some advantage to using first-differences instead of actual observations.[27] The third assumption is not likely to be completely fulfilled by any single equation designed to explain economic behavior. In this study there was reason to believe that simultaneous relationships could be neglected, at least during the early

---

[26] Ibid. p.37

[27] R. L. Anderson, "The Problem of Autocorrelation in Regression Analysis," Jour.Amer.Stat.Assoc., 49:113-129, 1954.

stages of analysis. Evidence supporting this viewpoint includes an observation that for any given week the supply of meat in the Lansing retail markets can be considered as predetermined. In addition, it is believed that most meat items are purchased on a current week-to-week basis and, therefore, storage demand or demand for non-food uses can be largely ignored. However, this does not preclude the possibility that simultaneous relationships may be uncovered as the analysis proceeds. If this occurs appropriate changes will be made in the procedures used for analysis.

Additional consideration of some of the other problems of single equation regression analysis will be taken up in Chapter V.

CHAPTER III

PREVIOUS INVESTIGATIONS OF DEMAND FOR MEATS

Based on Market Data

During the 1920's there were attempts to apply regression analysis to the problem of forecasting livestock prices.[1] Although these efforts were not designed primarily to measure demand elasticities, they represent some of the first applications of regression analysis to price-quantity data for livestock products. Probably the first concerted effort to obtain empirical measures of demand elasticities for meats was included in Henry Schultz's "The Theory and Measurement of Demand."[2] In this monumental treatise Schultz discussed the theory of related demands and tested some of his hypotheses with examples of demand equations for beef, pork and mutton. Using a single equation multiple regression technique, the average annual per capita consumption of beef, pork, and mutton were expressed as functions of their retail prices and

---

[1] G. C. Haas and Mordecai Ezekiel, Factors Affecting the Price of Hogs, U.S.Dept. of Agr., Bul.1440, 1926. Mordecai Ezekiel, "A Statistical Examination of Factors Relating to Lamb Prices," Jour. Pol. Econ., 35:233-60, 1927.

[2] Henry Schultz, The Theory and Measurement of Demand, University of Chicago Press, 1938, p.641.

per capita income. Equations (a), (b), and (c) summarize some of the results obtained.[3]

$$\text{(a)}\quad Q_b = 1.23 - \underset{(.07)}{.86}\,P_b + \underset{(.11)}{.10}\,P_p + \underset{(.21)}{.20}\,P_m + \underset{(.21)}{.48}\,I$$

$$\text{(b)}\quad Q_p = 1.19 + \underset{(.03)}{.19}\,P_b - \underset{(.05)}{.70}\,P_p - \underset{(.10)}{.004}P_m + \underset{(.10)}{.54}\,I$$

$$\text{(c)}\quad Q_m = 1.54 + \underset{(.07)}{.063}\,P_b + \underset{(.12)}{.37}\,P_p - \underset{(.22)}{1.80}\,P_m + \underset{(.22)}{.18}\,I$$

The price, cross, and income elasticities can be read directly from the equation since the data were fitted in logarithmic form. The figures in parentheses are the standard errors of the regression coefficients. The price elasticity for beef was -.86 as compared to -.70 for pork and -1.80 for mutton. The cross elasticity between the price of pork and the quantity of beef was non-significant while the price of beef apparently had a significant effect on pork consumption. The consumption of beef and pork shows little relationship to the price of mutton. The income-consumption elasticities for beef and pork are both close to +.50. In appraising these results it is essential to understand the nature of the data used. Annual average observations were used for the period 1922-1933. The quantity data represent carcass weights with beef and veal being combined. Lamb and mutton were likewise

[3] *Ibid.*, p.639.

combined. Prices used were Bureau of Labor Statistics average annual retail prices. These prices were deflated by the B.L.S. cost of living index as was the income variable. The quantity and income data were both placed on a per capita basis.

In 1935 Shepherd[4] made some estimates of the price elasticity of demand for pork, based on annual time series data. Using multiple graphic regression with the retail price of pork as the dependent variable and consumption of pork and consumer income as explanatory variables, he tentatively concluded that the price elasticity for pork was about -1.0 for the period 1921-34. Using alternative measures of consumer income in the same type of analysis gave price elasticities of -.55 and -.72. These latter elasticities were considered to be less reliable than the -1.0 due to the differences in the data used to measure income.

More recently Shepherd has made an analysis of changes in demand for meat and dairy products.[5] In his analysis of change in demand for meat he used a multiple correlation of four variables:

(1) U.S. average retail price of meat in cents per pound

(2) Per capita disposable income (index)

(3) Per capita consumption of meat (pounds of red meat)

(4) Time

---

[4] Geoffrey Shepherd, "The Incidence of the Processing Tax on Hogs," Jour.Farm Econ., 17:321-39, 1935.

[5] Geoffrey Shepherd, Changes in Demand For Meat and Dairy Products in the United States Since 1910, Iowa Agr. Exp. Sta., Ames, Iowa, Res. Bul. 368, 1949, p.381.

The data are annual observations for the period 1920-41. A single equation least squares fit of the relationship, with retail meat prices as the dependent variable, gave an R of .97 with all of the regression coefficients being significant at the one percent level. The price elasticity of demand turned out to be -.75. Shepherd concluded that this "appears reasonable in comparison with the elasticity of demand for pork, which is slightly higher than unity. One would expect the demand for meat to be less elastic than the demand for any one meat."[6] The income elasticity turned out to be 0.75. Evidence indicated that the demand for meat had declined slightly in relation to income between 1910 and 1946, but only as part of the general decline in expenditures for food as a whole.

In a detailed analysis of demand for meat, Working[7] has obtained several measurements of price and income elasticities. Using annual data for the years 1922-41 he has made some 22 different analyses using a single equation least squares method. One of the basic equations included these variables expressed in logarithms:[8]

---

[6] Ibid., p.387.

[7] Elmer J. Working, "Studies in the Measurement of Demand With Special Reference to the Demand for Meat. Unpublished Ph.D. thesis, Harvard University, 1952.

[8] Ibid., p.115

(1) Average retail price of meat

(2) Meat consumption per capita

(3) Deflated disposable personal income per capita

(4) Consumers price index.

Four regression equations were fitted to the data using each variable alternately as the dependent variable. Working then takes the geometric mean of the four regression coefficients for each pair of variables as the best estimate of the true structural parameters of the relations between the variables. In the analysis mentioned above the weighted regression coefficients indicated that a change of one percent in consumption is associated with a 1.45 percent change in retail price in the opposite direction and that a one percent change in "real" income is associated with a .75 change in price, also in the same direction. From this and several other analyses using different forms of some of the same basic data Working concludes that, "on the basis of the correlations reviewed it would seem most likely that the coefficient of price flexibility (the reciprocal of the coefficients of the elasticity of demand) is somewhere in the vicinity of -1.35 and -1.50"[9] The corresponding price elasticity range would be -.67 to -.74.

---

[9] *Ibid.*, p.123.

In an attempt to explore some of the "dynamics" of the demand for meat, Working made a regression analysis which included two consumption variables: the five-year average, and the current year as a percent of the five-year average. His conclusion was that, "in the long run the demand for meat is less inelastic than in the short run."[10] Working also cites evidence from his analyses that the demand for meat changes with changes in the general price level quite apart from the effect of the change in real income. This would partly explain the increase in demand for meat in the post World War II period when the general price level was rising rapidly.

Fox used the single equation method and annual data for the period 1922-41 to analyze the demand for a number of farm commodities, including meats.[11] Linear relationships were assumed and data were expressed as first-differences of logarithms. When per capita consumption of all meat was expressed as a function of the retail price of meat and disposable income per person, a price elasticity of -.64 and an income elasticity of .56 were obtained. Price elasticities for both beef and pork were reported to be about -.8 based on a similar

---

[10] Elmer J. Working, "Agricultural Demand During Rearmament," Jour. Farm. Econ., 34:218, 1952.

[11] Karl A. Fox, "Factors Affecting Farm Income, Farm Prices, and Food Consumption," Agr. Econ. Res., 3:65-111, 1951.

analysis. Income elasticities for beef and pork were about .7. Fox also found a competitive relationship between beef and other red meats. His analysis indicated that a ten percent increase in the supply of other red meats depressed the average annual price of beef by 5.2 percent.[12]

French[13] and Wahby[14] have applied some of the more recent statistical techniques to the problem of measuring demand for meats. Results were compared with those obtained using the more traditional single equation least squares methods.

French used a system of nine equations to explain the relationships in the market for meat. (Meat included all red meats, poultry and fish). The demand equation was solved by the maximum likelihood method and then compared to results obtained by ordinary least squares regression. The variables in the demand equation were annual observations for the U.S. for the period 1919-41.

Y_1 = per capita consumption of meat

Y_2 = retail price of meat

Y_3 = price of other food

---

[12] Karl A. Fox, The Analysis of Demand for Farm Products, U.S. Dept. of Agr., Tech. Bul. 1081, 1953, p.43.

[13] Burton L. French, Application of Simultaneous Equations to the Analysis of the Demand for Meat, Unpublished M.S. thesis, Iowa State College, 1949.

[14] Omar Wahby, Econometric Analysis of the Demands for Beef, Pork and Poultry Products, Unpublished Ph.D. thesis Iowa State College, 1951.

Y_4 = price of non-food

Y_5 = disposable income

Z = time

The results obtained by the two methods are summarized in the following equations:

(1) Limited information maximum likelihood method

$$Y_1 = -0.43\ Y_2 - 1.14\ Y_3 - 2.05\ Y_4 + 0.17\ Y_5 - 1.17\ Z_1 + 430$$

(2) Ordinary regression minimizing on quantity.

$$Y_1 = -0.81\ Y_2 - 1.14\ Y_3 - 2.05\ Y_4 + 0.18\ Y_5 - 0.78\ Z_1 + 504$$

(3) Ordinary regression minimizing on price and normalizing on quantity.

$$Y_1 = -1.27\ Y_2 - 0.58\ Y_3 - 1.31\ Y_4 + 0.19\ Y_5 - 0.44\ Z_1 + 380.$$

The signs associated with the coefficients were consistent for all equations, but the magnitudes of the coefficients are quite different, particularly with regard to the relationship between price and quantity of meat. The price and income elasticities computed at the mean values of the variables were:

Equation	Price Elasticity	Income Elasticity
(1)	-0.24	.50
(2)	-0.45	.53
(3)	-0.71	.58

Wahby set up a more detailed model of the meat market with separate demand equations for beef, pork and poultry products.[15] The complete model included 12 stochastic equations with the relationships assumed to be linear in logarithms. The variables included in the demand relationships are annual observations for the U.S., 1921-41.

Y_1 = quantity of pork consumed per capita
Y_7 = quantity of beef consumed per capita
Y_8 = quantity of poultry consumed per capita
Y_2 = retail price of pork
Y_3 = retail price of beef
Y_4 = retail price of poultry products
Y_5 = retail price of dairy products
Y_6 = retail price of oleomargarine
Z_1 = time
Z_3 = retail price of other food
Z_4 = disposable income per capita
Z_5 = moving average of Z_4 for the preceding 5 years

As originally set up, the equations included were over-identified. Consequently, the limited information method of estimation was followed in solving for the relationships. The results obtained were unsatisfactory when measured against *a priori* knowledge. Therefore, the model was altered slightly

---

15 *Ibid.*, p.14.

so as to make possible the use of reduced form solutions. The results are shown below:

(1) Pork equation

$$Y_1 = -0.91\ Y_2 + 0.60\ Y_3 + 0.87\ Y_4 - 1.23\ Y_5 - 0.91\ Y_6$$
$$- 0.03\ Z_1 + 0.16\ Z_3 + 0.76\ Z_4 + 0.29\ Z_5 + 2.70$$

(2) Beef equation

$$Y_7 = -0.77\ Y_3 + 0.52\ Y_2 + 0.67\ Y_4 - 0.22\ Y_5 - 1.09\ Y_6$$
$$- 0.02\ Z_1 + 0.29\ Z_3 + 0.65\ Z_4 - 0.12\ Z_5 + 3.06$$

(3) Poultry products equation

$$Y_8 = -0.68\ Y_4 + .12\ Y_2 + 0.28\ Y_3 + 0.22\ Y_5 + 0.31\ Y_6$$
$$+ 0.001\ Z_1 + 0.36\ Z_3 + 0.53\ Z_4 + 0.28\ Z_5 - 0.42$$

The elasticities can be read directly from the equations since the variables were expressed in logarithms.

In a recent study of demand for meat in Canada, the price elasticity of demand at the wholesale level was estimated to be -.65.[16] Annual data summarized on a September-August marketing year basis was used for the period 1926 to 1942. The variables used in the single equation regression analysis were as follows:

X_1 = weighted average wholesale price of all red meat divided by the general wholesale price index.

X_2 = average domestic consumption per capita for all meat.

---

[16] F.M.Schrader, The Demand for Meat in Canada, Economics Division, Canadian Department of Agriculture, Ottawa, 1953.

X_3 = the index of industrial production per capita reflecting consumers' ability to purchase goods and services.

The regression equation was:

$$\log X_1 = 1.9438 - 1.5390 \log X_2 + 1.0118 \log X_3$$

The price elasticity is the reciprocal of -1.5390 or -.65. Similarly, the income elasticity is estimated to be .99. Shrader estimates that the price elasticity of demand for meat at the retail level is -1.05 and about -.40 at the farm level.

Studies made by Jureen indicate that price and income elasticities of demand for meats were lower in Sweden than in the U.S. Multiple regression analyses of annual data for the period 1921-1939 were used in deriving the elasticities (Table 2).

Table 2

ELASTICITY OF DEMAND FOR MEAT, SWEDEN, 1921-1939*

Kind of Meat	Price Elasticity		Income Elasticity
	Separate Price Changes	Proportional Price Changes	
All meat	---	.28	.28
Beef	.50	.22	.30
Pork	.45	.31	.33

* Herman Wold and Lars Jureen, Demand Analysis. John Wiley, New York, 1953 p.282.

The quantity data were estimated consumption per person for the entire country. The prices were takes at the retail level.

Another approach, which differs from the analyses discussed above, has been used to examine the competitive relationship between different kinds of meats. Using this method the price ratios for two different items is related to the quantity ratios existing in different time periods. Clawson made several graphical comparisons of this type.[17] In one chart, he plotted the cattle/hog price ratio against the beef/pork consumption ratio for the years 1899 to 1939. By inspection he draws two lines of relationship between the two ratios: (A) for the years 1899-1914 and 1934-1939; (B) for 1913-1933. Both lines slope downward to the right and are slightly convex to the origin. Little attention was given to an explanation as to why there are two different lines of relationship. The correlation between the price and quantity ratios was .87 and .97 for the two groups of years. The elasticity of the lines, measured roughly at different points on the curve, varies from -.33 on the A curve to well over -1.0 on the B curve.

Szatrowski[18] used a multiple regression analysis which

---

[17] Marion Clawson, "Demand Interrelations for Selected Agricultural Products," Quar.Jour.Econ., 57(2):265-502, 1943.

[18] Zenon Szatrowski, "Time Series Correlated with the Beef-Pork Consumption Ratio," Econometrica, 13:60-78, 1945.

expressed the annual beef-pork consumption ratio as a function of the following variables:

X_1 = time

X_2 = beef-pork price ratio (actually cattle-hog price ratio)

X_3 = consumption ratio of preceding year

X_4 = cattle-hog population ratio

X_5 = corn yield of previous year in bushels per acre

X_6 = income in dollars per capita

Results indicate a negative relationship between the price and quantity ratios with a regression coefficient of about -.5.

Both Clawson's and Szatrowski's price ratios are based on live animal prices and therefore do not represent the price to which consumers react. Variations in by-product values on cattle, lard values on hogs and marketing costs cause the relationship between live animal and retail prices to change.

Woodlam[19] has also made a regression analysis of the price and quantity ratios for beef and pork using Canadian data for the period 1928-1951 omitting the war years. He used the wholesale price of carcass beef on the Toronto market and estimates of consumption based on production data that were adjusted for exports, imports and changes in storage stocks.

---

[19] G. E. Woodlam, The Influence of Prices on the Relative Consumption of Beef and Pork, Economics Div., Canadian Dept. of Agr., 1953.

In his analysis he finds that --

$$\log X_1 = 4.075 - 1.029 \log X_2$$

where X_1 is the consumption of beef expressed as a percentage of the consumption of pork and X_2 is ratio of prices in terms of percent. The interpretation of the results of these studies based on price and quantity ratios is not clear. Presumably the high correlation between the two ratios and the significant regression relationship is offered as evidence that beef and pork are competitive items. This may be subject to question since it can be demonstrated that the price and quantity ratios are highly correlated for two independent goods with price elasticities of approximately -1.0. The slope of the regression function between the price and quantity ratios might provide some evidence on the competitive relationship between two goods providing the price elasticities were known in advance.

Cross-Sectional Budget Studies

Several cross-sectional surveys have been conducted to obtain information on the relationship between certain socio-economic factors and the demand for meat. In 1934, a survey of 2200 families was made in Minneapolis.[20] One of the prin-

---

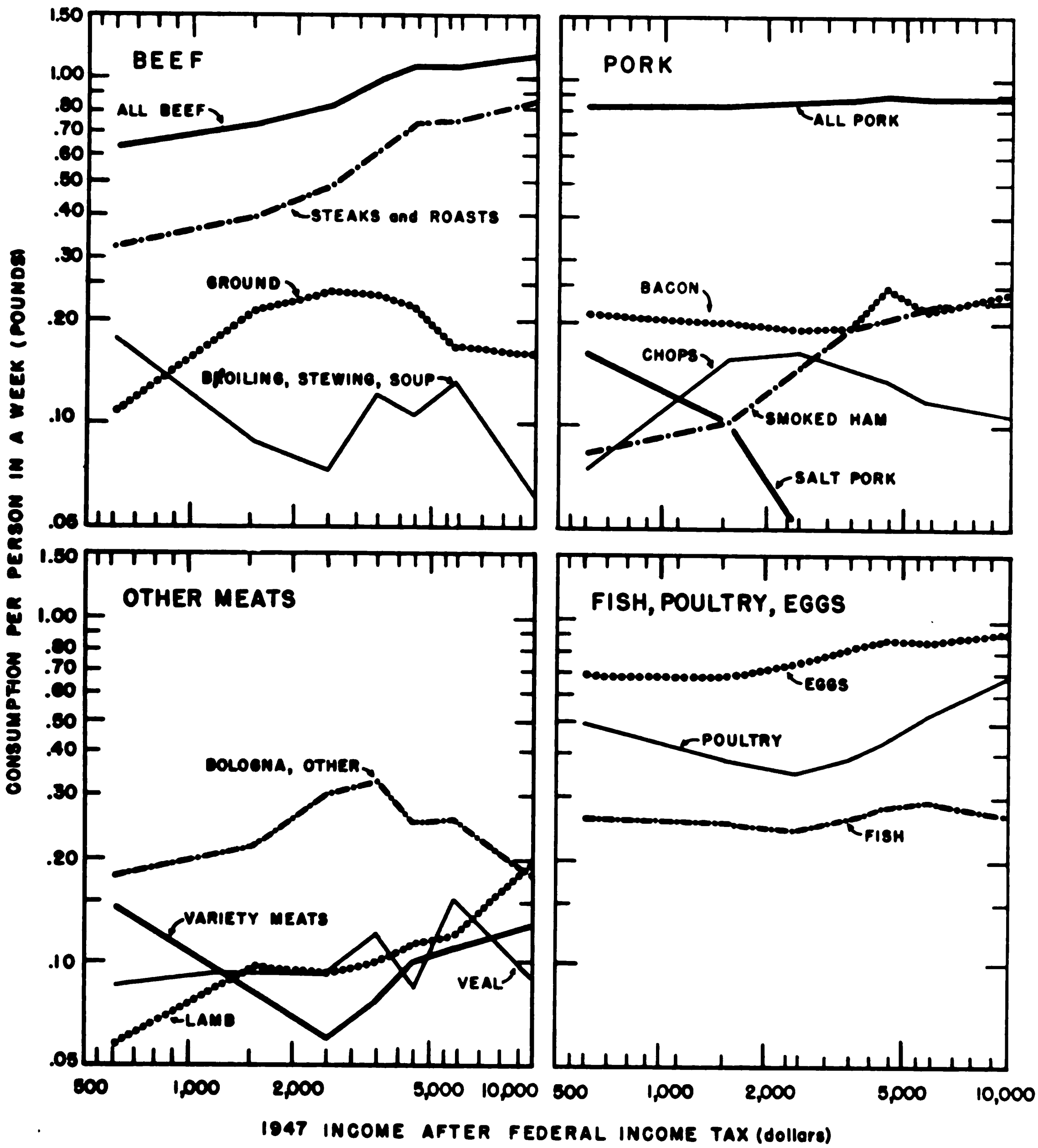
20 W.C.Waite and R.W.Cox, A Study of the Consumption of Meats in Minneapolis, 1934, Minn. Agr. Exp. Sta., Bul. 321, 1935.

cipal conclusions was that income exercises a predominant influence on meat consumption with the higher income families spending nearly three times as much per person for meat as compared to families in the low income groups. The study also indicated that size and composition of families had only a minor influence upon per capita meat consumption. It should be noted that this survey was made at a time when unemployment was large and incomes generally depressed.

During 1948, the Bureau of Human Nutrition and Home Economics of the U.S. Department of Agriculture made a survey of some 1600 urban families to study their food consumption habits. Although consumption patterns varied between cities, the relationship between income and per capita meat consumption is summarized in an illustration taken from the publication reporting the results of the study[21] (Figure III). It can be seen that the quantity of beef increases with rising income, while pork consumption remains about constant. However, the consumption of particular cuts of meat show mixed patterns. For example, ground beef consumption increases as incomes increase up to $4,000 per family. Beyond $4,000 ground beef consumption declines. A similar pattern exists for pork chops, bologna and other cold meats. Salt pork is the only item that

---

[21] Bur. of Human Nutr. and Home Econ., U.S.Dept of Agr., Meat Selections of City Families, Commodity Summary No.1, 1949.



SOURCE: Bur. of Human Nutr. and Home Econ., U.S.Dept. of Agr., Meat Selections of City Families, Commodity Summary No. 1, 1949, p.7.

Figure III. Relationship between family income and meat consumption, urban housekeeping families, United States, spring, 1948.

consistently behaved as an "inferior product." The study also showed that total meat consumption increased with income, but leveled off at family incomes of $4,000 and over. As incomes increased meat expenditures increased more rapidly than quantities consumed due to the fact that the higher income families purchased higher priced cuts of meats.

A series of income-consumption elasticities were computed by Waite and Trelogan from the 1948 survey data mentioned above. These are summarized in Table 3.

Table 3

INCOME-CONSUMPTION ELASTICITIES FOR SELECTED MEAT ITEMS URBAN FAMILIES, UNITED STATES, SPRING, 1948*

Kind and Cut of Meat	Elasticity
Pork chops	-0.21
Ground beef	-0.13
Bacon	0.10
Beef, boiling and stewing	0.36
Beefsteak, round	0.55
Poultry (total)	0.64
Smoked ham (cooked)	0.82
Beefsteak, other than round	1.04

* W.C.Waite and H.C. Trelogan, Agricultural Market Prices, John Wiley, 2d ed. 1951, p.41.

The above elasticities are simple arc elasticities using the second income group, with an average family income of $1,555, and the sixth income group, with an average income of

$5,861. Average family consumption was the quantity variable. The existence of wide variations in meat purchases among families of the same income grouping[22] suggests that the reliability of these estimates of income elasticity may be rather low.

A cross-sectional survey of 726 families was made in Syracuse, New York, in the spring of 1948.[23] These same families had been surveyed in 1942. During the intervening six-year period the income position of these families and their meat consumption had shifted considerably. One group of families with a slight decrease in income reported a decrease of 11 percent in per capita meat consumption. These families had below medium income in 1942. Another group of families with the largest increase in incomes between 1942 and 1948 (114) percent) reported an average increase of 65 percent in the quantity of meat purchased per capita. Families were classified on the basis of per capita income rather than family income as in the 1948 surveys made by the BHNHE. The Syracuse study also analyzed the shift in consumption of different kinds of meats among the different families. Not only did the families with the greatest rise in income increase

---

[22] Bur. of Human Nutr. and Home Econ., U.S.Dept. of Agr., Meat: Variations in Consumption and Interrelationships with Other Foods, Commodity Summary No.11,1951,p.3.

[23] Will M. Simmons, Consumer Meat Purchases in Syracuse, New York, 1948 and Comparison with 1942, Cornell Univ.Agr. Exp. Sta., Ithaca, New York, Bul. 869, 1951.

their meat purchases, but there was a noticeable shift toward the higher valued, "more desirable" cuts. Thus, the results are relatively consistent with the relationships found in the cross-sectional analysis of the BHNHE survey data discussed earlier.

In the spring of 1950, a sample survey of 1385 families was made in Lansing, Michigan. Family characteristics and food purchases for a period of one week were obtained. Moss[24] analyzed these data to determine some of the relationships of socio-economic factors, such as family income and size of family, to per capita food consumption and expenditures. Cross-sectional tables were used and the difference between means tested by analysis of variance procedures. Family income and size of family appeared to be most important factors affecting per capita meat consumption (Table 4). Since these two factors exhibited a positive relationship it was desirable to test their relationship with per capita meat consumption while holding one or the other constant. When size of family was controlled, family income was not significantly related to per capita consumption of pork, lamb and mutton, poultry, fish, or seafood (Table 4). Certain irregularities can be noted. For example, consumption of red meats rises as incomes

---

[24]Thomas N. Moss, Some Relationships of Selected Socio-Economic Factors to Food Consumption and Expenditures, Lansing, Spring, 1950. Unpublished Ph.D. thesis, Michigan State College, 1952.

TABLE 4

SIGNIFICANCE OF DIFFERENCES IN PER CAPITA CONSUMPTION OF SELECTED MEAT ITEMS WHEN RELATED TO SPECIFIED SOCIO-ECONOMIC CHARACTERISTICS, LANSING, SPRING, 1950 f/

Socio-Economic Characteristic	Significance of relationships with per capita consumption							
	All Red Meats	All Beef	All Pork	All Lamb & Mutton	Poultry	Fish & Seafood	Ground Beef	Beef-Steak
Family income with size of family constant	no a/	yes (+)	no	no	no	no	yes d/	yes (+)
Size of family with income constant	yes (-)	yes (-)	yes (-)	no	no c/	yes	no	yes (-)
Age of housewife, with income and size of family constant	yes b/	no	no	no	no	no	yes c/	no
Education of housewife with income and size of family constant	no	no	no	no	no	no	no	no
Size of weekly food bill with income and size of family constant	Yes (+)	no	no	no	no	no	yes (+)	no

a/ Significant difference between low and medium and low and high income groups, but not between medium and high.
b/ Per capita expenditures not significantly related.
c/ Per capita expenditures significantly related.
d/ Per capita consumption of ground beef increases from low to medium income group and then declines for high income group.
e/ Housewives over 56 years of age purchased less than housewives in the younger age groups.
f/ Thomas N. Moss, Some Relationships of Selected Socio-Economic Factors to Food Consumption and Expenditures, Lansing, Spring, 1950. Unpublished Ph.D. thesis, Michigan State College, 1952.

rise up to the medium income level and then levels off. Ground beef consumption increases from low to medium income group, but then declines from medium to high income group.

Age and education of the housewife had little influence on meat consumption after sorting by size of family and family income. As the size of the week's food bill increased, beef purchases rose significantly.

It has been pointed out that family income and size of family were positively related and both were significantly related to the consumption of several different meats. For practical application it would be helpful to know more about the direction and magnitude of these relationships.

Using data in Moss's thesis a series of simple arc elasticities were calculated. (See Table 5.) It was found that the income-consumption elasticities varied considerably by size of family and that elasticities are much higher between the low and medium income groups than between the medium and high income group. In fact, a negative elasticity exists for ground beef when comparing the medium and high income group. These elasticities point up the importance of adjusting for size of family before calculating an income elasticity. In the elasticities computed by Waite and Trelogan (Table 3), the influence of size of family distorts the "true" relationship between family income and consumption.

TABLE 5

INCOME-QUANTITY ELASTICITIES FOR MEAT ITEMS BY SIZE OF FAMILY - LANSING, SPRING, 1950[a]

Kind of Meat	Size of Family	Elasticity Between Income Groups[b]	
		Low to Medium	Medium to High
All meat	1-2	.67	.06
	3-4	.27	.04
	5 or more	.05	.12
Beef	1-2	.68	.20
	3-4	.41	.16
	5 or more	.28	.06
Pork	1-2	.48	-.06
	3-4	.08	.00
	5 or more	-.16	.15
Ground beef	1-2	.76	-.72
	3-4	.40	-.10
	5 or more	.24	-.26
Beef steak	1-2	.81	.52
	3-4	.52	.30
	5 or more	.80	.45

a Data taken from Moss's Ph.D. thesis. Formula used to calculate elasticities was

$$\frac{\dfrac{q^2 - q^1}{q^1 + q^2}}{\dfrac{I_2 - I_1}{I_1 + I_2}}$$

b Low income group includes families with incomes under \$3,000; mean of group = \$1,900.
Medium income group includes families with incomes of \$3,000 to \$4,499; mean of group = \$3,542.
High income group includes families with incomes of \$4,500 and over; mean of group = \$6,074.

It is sometimes difficult to reconcile income elasticities derived from time series data with those derived from budget studies. In addition to the disturbing influence of factors such as size of family, there is also a question as to how readily families take on the consumption habits of a higher income group as their incomes rise relative to other families. This thesis will not develop these aspects of income elasticity, however, the empirical relationships presented in this section will assist in the interpretation of the results of analyses to be presented in subsequent chapters.

Summary

Most of the demand studies using market observations are based on annual aggregative data for the period between World Wars I and II. In most cases a single equation least squares technique has been used with minor variations in the procedures for adjusting the data. Therefore, it is not surprising that there should be rather close agreement in the results obtained from these analyses. The estimates of price elasticity of demand for all meats ranges from -.64 to -.75. The price elasticity estimates for beef and pork are less inelastic than for all meat with a range from -.70 up to -1.0. Income elasticities range from about .50 up to .75, with the lower estimate being associated more closely with real income where the price and income series have been deflated by a consumer price index. Where the income data were expressed in current dollars the income elasticities approach the upper end of the range.

The only major deviation in elasticities resulted from an attempt to use the limited information method of estimation. The price elasticity for all meat, using this method, turned out to be rather low as compared to a least squares fit of some of the same data.

Some rather important questions have been raised as to the usefulness of elasticity estimates based on studies of inter-war period conditions as a basis for predicting economic behavior in the postwar years. Kuznets[25] criticizes the assumption underlying these studies that certain "social variables" remain constant or change slowly and smoothly over time. Some of these factors which are usually assumed away under the <u>ceteris paribus</u> of accepted demand theory include (1) changes in the distribution of real disposable income, (2) lags in consumer adjustment to rapidly changing prices and income situations, (3) changes in eating habits and (4) changes in the composition and distribution of the population.

---

[25]G.M. Kuznets, "Measurement of Market Demand with Particular Reference to Consumer Demand for Food." Jour. Farm Econ., 35:878-893, 1953.

During the past thirty years there have been significant and in some cases rapid changes in some of these social variables. Between 1941 and 1944 there was a marked improvement in the relative status of the lower income segments of the population, particularly for families of two or more.[26] This gain in income position was further accentuated by sharp increases in income taxes which occurred during this same period. Available evidence indicated that changes in occupations, the trend toward urbanization, improvements in refrigeration, plus many other factors, have contributed to changes in demand for food items.[27] It seems questionable that an elasticity representing the entire range of price, quantity, income variations during the interwar period can be expected to perform with a high degree of predictive accuracy under the present economic and social environment. *A priori* reasoning suggests that price and income elasticities for different food items might be one thing during a period of depressed economic activity and quite another dur-

---

[26] Council of Economic Advisors, The Economic Situation at Midyear, 1951, A Report to the President, U.S. Gov't. Printing Office, pp. 90 and 96.

[27] Bur. of Agr. Econ., U.S.Dept. of Agr., Agricultural Outlook Charts, 1954, p.24; Marguerite Burk, "Changes in Demand for Food from 1941 to 1950," Jour. Farm Econ., 33:281-298, 1951; Earl E. Miller, "Changes in Demand for Pork Products," The Livestock and Meat Situation, Bur. of Agr. Econ., U.S.Dept. of Agr., May-July, 1953, pp.14-19.

ing a period of full employment and high incomes. Similarly, it might be argued that price elasticities are likely to be different when supplies are large as compared to when supplies are average or small. However, in many empirical demand studies a demand curve of constant elasticity has been fitted to the data. In some cases this may be justified and certainly it has some advantages of simplicity in computation. This suggests that the usefulness of elasticity estimates may be hampered by a tendency toward over-simplification. Instead of a single elasticity for a commodity there might well be whole family of elasticities. Detailed demand studies at both the micro and macro levels and for time periods of different lengths are essential to the development of a more useful set of functional relationships.

Another shortcoming of the interwar elasticity estimates is that they apply to large groups of food items and may represent such a high degree of aggregation so as to have limited use in everyday problem solving. For example "meat" may include everything from fish to beef, and within sub-groups, such as beef, there are many different grades and retail cuts. In any particular time period prices and supplies of these sub-groupings may be moving in different directions, and over a period of time the relative proportions of each group changes. This makes it difficult to construct a representative price and quantity series of data over time. Fox[28] found that a simple average price in some cases moved in the opposite direction from a weighted average price.

The consumption data used in all of the studies reported above were based on carcass weights at the wholesale level whereas the price series are based on the retail prices collected by the Bureau of Labor Statistics in 55 large cities throughout the United States. Using the carcass weight data on beef, pork, veal and lamb, it is impossible to treat separately the processed sausage items which may have somewhat different consumer demand characteristics than fresh beef or fresh pork. The price series are based on a few retail cuts of a specific grade of meat and therefore cannot adequately reflect price changes when the price spreads between grades fluctuates.

Although numerous criticisms have been directed toward inter-war period elasticity studies based on market data, it should be recognized that these studies have been limited by the availability of adequate data. The results obtained, have provided an essential background for the development of more detailed demand studies as suitable data becomes available.

---

[28] Karl A. Fox, The Analysis of Demand for Farm Products, U.S.Dept. of Agr., Tech. Bul. 1081, 1953, p.26.

CHAPTER IV

THE SOURCE AND NATURE OF DATA

The Operation of the Consumer Panel

The M.S.C. Consumer Panel is a group of 200 to 250 families residing in Lansing, Michigan, who keep detailed records of their food purchases. Diaries are filled out each week showing the price, quantity, and total expenditure for each food item purchased. (See Appendix for copy of diary). These diaries are then mailed to the Department of Agricultural Economics, Michigan State College, where the data are transposed onto IBM cards. The principal source of data for this dissertation was these food purchase records.

The first diaries from the panel were received in February, 1951; however, it was late summer of that year before as many as 200 families were reporting regularly. Since that time the number of panel members has risen to about 250. The project, which supports the panel, was approved in late 1948 and was designed to run for ten years.

The objectives of the original project were as follows:

> "The first is to determine the effect of price changes (both real and money) upon the quantities of food purchased, and the associated time-lag in adjustment. The second objective is to determine the effect of a change in income (both real and

> money) upon the quantity purchased and the expenditure for various food products, and the associated time-lag. The third objective is to measure the effect of price changes and income changes upon substitution among different products. In a sense, therefore, the objectives are to determine price elasticity, income elasticity and cross elasticity of demand."[1]

The leadership for the organization and operation of the panel has been the responsibility of Dr. Gerald G. Quackenbush and Dr. James D. Shaffer. Dr. Shaffer's doctoral dissertation dealt with the methodological problems of organizing and operating the panel.[2]

This dissertation will touch briefly upon some of the characteristics of the sample as they affect the representativeness of the data that were used in the analysis of demand for meats. A more detailed discussion of the sampling plan can be found in Dr. Shaffer's doctoral thesis and in a recent journal article.[3]

The first step toward obtaining a representative sample of families was to conduct a sample census of the Lansing

---

[1] Gerald G. Quackenbush, "Demand Analysis from the M.S.C. Consumer Panel," Jour. Art. No. 1594 of the Michigan Agr. Exp. Sta. A paper delivered at joint meeting of the Amer. Stat. Assoc., and the Amer.Farm Econ. Assoc., Washington, D.C., Dec. 30, 1953.

[2] James D. Shaffer, Methodological Bases for the Operation of a Consumer Purchase Panel, Unpublished Ph.D. thesis, Michigan State College, 1952.

[3] James D. Shaffer, "A Plan for Sampling a Changing Population Over Time," Jour.Farm Econ., 36:153-63, 1954.

population to learn more about its characteristics. A random sample of 2000 families was systematically selected by taking every nth residential address from the complete list of addresses in the Lansing City Directory published by R.L. Polk and Company. The sampling rate was approximately seven percent. The same area, as defined in the city directory, included corporate Lansing plus the highly urbanized fringe but excluded East Lansing. A total of 1885 interviews were completed in the spring of 1950. From this group a subsample of 300 families was drawn, stratified on the basis of income of the household, number in the household, age of the housewife, and education of the housewife. A plan was set up whereby panel members received about fifty cents per week for keeping the food diary.

As would be expected, not all families would agree to be cooperators. The families least likely to cooperate were those in low or high income groups, those where the housewife had an 8th grade or less education, those with broken homes, those where the housewife was elderly, and those where both the husband and wife were employed.[4]

As panel members drop out, new members are recruited from the list of families catalogued in the sample census.

---

[4] Ibid.,p.156.

The new family is selected so as to be as much like the old family as possible. When families move out of the city, an attempt is made to replace them with new families moving in to the city. Provisions are also made for picking up a proportionate number of newly formed families so as to maintain a representative sample over time.[5] A second sample census was made in 1954 as a basis for revising the sample and to provide a new pool of potential members.

The Characteristics of Lansing

1950 census. Some knowledge of the basic characteristics of the Lansing population is essential to an appraisal of the research findings based upon data from the M.S.C. Consumer Panel. One of the best standards of comparison now available is the published results of the 1950 census of population. Table 6 summarized this information for Lansing, the state of Michigan, and the United States.

These statistics indicate that Lansing is a city with a fairly high level of income. The median family income in 1949 was $4,097. This is one-third above the average for the United States and is 19 percent above the average income of urban families in the United States. This higher than average income level is also evidenced by the relatively small percent of families with incomes under $2,000 per year and the higher than average proportion with incomes over $6,000.

---

[5] Ibid.,p.159.

TABLE 6

CHARACTERISTICS OF THE LANSING POPULATION, 1950 CENSUS*

Characteristic	Lansing	Michigan	Urban Michigan	United States	
				Urban	Total
Percent 65 years old or over	8.0	7.2	6.6	8.1	8.1
Percent non-white	3.3	7.1	9.5	10.0	10.4
Persons per household	3.16	3.42	3.39	3.24	3.38
Percent of males 14 years old and over in labor force	81.5	80.1	81.9	76.1	76.4
Percent of females 14 years old and over in labor force	36.3	27.3	30.2	42.5	36.7
Percent labor force unemployed	4.8	5.4	5.8	5.6	4.3
Percent employed in manufacturing	33.8	40.9	44.3	29.4	25.9
Median income families	$4097	$3519	$3815	$3431	$3073
Percent of families with incomes less than $2,000	20.7	28.4	24.4	32.6	38.6
Percent of families with incomes over $6,000	21.6	15.7	18.6	15.3	12.3

*SOURCE: U.S.Bur. of Census, 1950 Census of Population, Vol.II, Characteristics of the Population.

Other population characteristics which might be of interest in studying demand for food, are the low percentage of non-whites in the population, the smaller than average size of households, and the high proportion of persons employed in manufacturing compared with the average for the United States. The proportion of persons engaged in manufacturing, however, is low compared to the average for urban areas in Michigan. This is probably due to the fact that Lansing, being the state capital, has a sizeable number of persons employed in public administration positions. As is true in many other cities in Michigan, the manufacturing industry is dominated by firms producing motor vehicles and motor vehicle parts.

Other characteristics of Lansing, which might be of use in appraising the demand for meat, include location with respect to livestock production and slaughter, the kinds and sizes of retail outlets, and the amount and kind of meat advertising.

Deficit areas in meat production. Michigan is a deficit area from the standpoint of livestock production as related to meat consumption (Table 7). Liveweight farm production of meat animals is equivalent to about 44 percent of total meat consumption in the state. Due to substantial in-shipments of live animals to slaughterers, dressed meat production is 76 percent of total consumption. The largest deficit is in pork products. A high proportion of the beef produced on Michigan farms comes as a by-product of the dairy industry. Therefore, a higher percentage of the locally produced beef would grade U.S. Commercial and lower. Veal production is relatively high in relation to consumption; whereas lamband mutton production probably is about equal to or slightly less than consumption.

Meat retailing in Lansing. The organization and operation of retail stores handling meat in Lansing is not unusual for a city of this size. Three large national chains operate stores in or near Lansing. These firms are The Atlantic and Pacific Tea Company, National Tea Company, and The Kroger Company. A local chain operates three supermarkets, and until 1953 another local chain operated six supermarkets. The second local chain has since been bought out by National Tea. These firms operate a total of 19 supermarkets in or near Lansing, 17 of which carry a complete line of self-service meats. In addition to these larger stores, there are several individually owned superettes and a large number of small neighborhood groceries which carry meats.

Up until February 1953, when price controls were lifted, most of the larger supermarkets featured U.S. Choice grade beef. Since that time, about one-third of the stores have dropped down to U.S. Good grade or its equivalent in packer

TABLE 7

PRODUCTION AND CONSUMPTION OF MEATS IN MICHIGAN[a]

Kind of Meat	Percent of U.S. Total		
	Liveweight Farm Production 1947	Dressed Meat Production by Slaughterers 1947	Meat Consumption Jan.-Mar. 1944
Beef	2.05[b]	3.55	--
Veal	--[b]	3.92	--
Lamb and mutton	1.63	1.51	--
Pork	1.39	2.31	--
All Meat	1.72	2.94	3.89

a Grover J. Sims and Lucile Johnson, "Geography of Meat Animal Production and Meat Consumption," Livestock and Meat Situation, Bur.of Agr.Econ.,U.S.Dept.of Agr., August 1948, pp.17-23.

b Beef cattle and calves are combined in the total for beef.

brands.[7]

Competition is fairly keen among the larger stores. Each week these stores run large ads in the food section of the Lansing State Journal which is the only local daily newspaper. It seems probable that this may affect the relative quantities of the different cuts of meat purchased in Lansing in any given week, particularly when the same cut, or same kind of meat, is featured as a special by more than one chain.

Representativeness of the Panel Over Time

In appraising the reliability of the data from the M.S.C. Consumer Panel, it is important to know something of the representativeness of the sample over time. It has already been pointed out that some difficulty was encountered in establishing the original sample so as to be completely representative of the population as classified in the sample census. Perhaps, even more important is the stability of the sample over a period of time.

When characteristics of the sample are compared to those of the sample census, it appears that the panel has

---

[7] While O.P.S. controls were in effect all beef was government graded. With the suspension of controls grading was no longer compulsory.

remained relatively stable over the two year period 1951 to 1953 (Table 8). The average age and education of the housewife has tended to be slightly above the levels found in the sample census. The number of persons per family has been maintained near the sample census average of 3.28 with deviations within a range of one-tenth person above and below the average.

In appraising the stability of the sample with regard to level of income, it must be remembered that families are classified on the basis of last year's income. The basis for calculating the average income of panel members changes each January 1. In comparing the income levels in Table 8 it is necessary to take into account the general upward trend in income payments.

Last year's income for panel members reporting during the week beginning July 1, 1951, was $4,463. With few exceptions average family income fluctuated between $4,000 and $4,100 during 1951 (based on 1950 income). This is approximately $300, or eight percent, above the sample census average of $3,738 (based on 1949 income). Since national average disposable personal income increased by eight percent from 1949 to 1950, the panel appears to have been fairly representative as to level of income during most of 1951.

If family incomes in Lansing moved parallel to national disposable income per person, the average level of income for panel members in 1952 (based on 1951 realized income) should

TABLE 8

CHARACTERISTICS OF THE AVERAGE FAMILY IN THE M.S.C. CONSUMER PANEL AT DIFFERENT TIME PERIODS COMPARED TO THE AVERAGE FAMILY IN THE 1950 SAMPLE CENSUS

Family Characteristic	1950 Sample Census[a]	M.S.C. Consumer Panel July 1 1951	Jan. 1 1952	July 1 1952	Jan. 1 1953	June 30 1953
Average age of housewife (years)	42.7	44.1	45.0	45.5	45.6	46.6
Average education of housewife (years)	10.9	11.2	11.1	10.9	11.2	11.3
Average family income last year (dollars)	3758[b]	4463[c]	4184[d]	4036[d]	4406[e]	4584[e]
Average number of persons per family	3.28	3.28	3.39	3.23	3.29	3.18[f]
Number families reporting	1885	179	207	223	242	230

a Personal interview survey of 1885 Lansing families.

b 1949 income after taxes.

c 1950 income after taxes

d 1951 income after taxes

e 1952 income after taxes.

f A sample census of 1,110 families in the spring of 1954 revealed an average size of family of 3.18.

have been $4,359. On this basis the actual level appeared to be less than desired for an optimum sample; however, this seemed to have been corrected as the panel moved into 1953. The panel average of $4,584 for June 30, 1953 was about 22 percent above the 1949 level of $3,738. This compared with an overall increase in national disposable income of 19 percent for the corresponding period.

Local income data on gross weekly earnings of manufacturing workers in Ingham County, where Lansing is located, showed an increase of 21 percent from the last half of 1951 to the first half of 1953. Weekly average income of panel members reported on a current basis rose 16 percent during the same period. The difference in rate of increase could be due to the lag in wage increases received by non-manufacturing workers and to the increase in overtime pay for manufacturing workers. Families with fixed incomes also affected the panel average.

In spite of minor fluctuations in the characteristics of the panel, as measured by averages on control factors, such as age and education of housewife, size of family, and family income, it appears that the panel group has been reasonably representative over time.

Another aspect of the sampling problem is the continuity of participation of panel members. Table 9 shows a frequency distribution of families that have participated in the panel for varying lengths of time. This indicates a considerable stability of the panel since it began in the spring of 1951.

TABLE 9

FREQUENCY DISTRIBUTION OF FAMILIES PARTICIPATING CONTINUOUSLY IN THE M. S. C. CONSUMER PANEL FOR VARYING LENGTHS OF TIME*

Length of Time Participating	Number of Families	Cumulative Number of Families
More than $2\frac{1}{2}$ years	50	50
2 to $2\frac{1}{2}$ years	38	88
$1\frac{1}{2}$ to 2 years	37	125
1 to $1\frac{1}{2}$ years	27	152

* Based on families in panel for week ending October 24,1953. Continuous participation is defined as families not missing more than two weeks diaries in the time period.

Preliminary Processing of the Data

<u>IBM analysis</u>. When this study of demand for meat began in November 1952, the procedures had been set up for coding the data from the panel diaries and punching them on IBM cards.[8] A listing of the IBM cards by families was being used to check against the original food purchase diaries for errors or omissions. Each week's purchase records requires approximately 6,300 IBM cards. This does not include the different sets of summary cards which are punched as the analysis proceeds.

[8] These procedures for IBM analysis were developed and carried on under the supervision of Dr.G.G.Quackenbush and Dr. J. D. Shaffer.

When this meat study began approximately 330,000 IBM cards were available from more than one year's operation of the M.S.C. Consumer Panel. As the study progressed IBM cards became available for another year of panel operation.

The basic IBM cards were sorted into three income groups and within each income group the cards were serialized by product number. The income groups were set up so as to divide the panel families into three groups each containing about an equal number of families. The income measure used as a basis of classification was last year's annual income after federal income taxes. The product numbers were those listed in the food purchase diary. (See Appendix).

The IBM cards were then summarized and tabulated so as to yield the following information on a weekly basis for each of the major meat groupings, such as beef, pork, veal, etc.:

(1) Total quantity purchased by all families by income groups.

(2) Total expenditures by all families by income groups.

(3) Average price by income groups arrived at by dividing total expenditure by total quantity.

(4) Average quantity purchased per family by income groups.

(5) Average quantity purchased per capita by income groups.

(6) Percent of families buying.

At a later date a similar analysis was made for retail cuts of meat. However, this was confined to a summary for the entire panel disregarding income groupings of families.

Adjusting the data. The weekly observations on quantity per family, average price, and percent buying were plotted graphically for each of the major meat groups (beef, veal, lamb, pork, other meats, poultry, and fish). It was apparent from these graphs that fluctuations in average prices and average quantities, based on the panel data, were more erratic than could reasonably be expected from similar observations for the entire population. This brought about a careful rechecking of the data where several processing errors were discovered and corrected. This, however, did not remove all of the seemingly erratic observations.

Further checking disclosed that locker purchases, gifts, and game were causing substantial disturbances in the average price and average quantity series. It was reasoned that the sample of families in the panel was too small to provide reliable estimates of weekly locker purchases occurring in the total population. For example, in a week when one family purchased a 300 pound side of beef the average weekly purchases for all panel families would be increased by more than one pound per family. With typical purchases averaging near $2\frac{1}{2}$ to 3 pounds per family per week, the occurrence of a locker purchase represents a greater shift in purchases than was likely to be true for the total population. The average price was also biased downward since locker purchases are usually reported on the basis of a wholesale price. Therefore, it was decided that locker purchases should be adjusted out of the data for this study of consumer response to price changes. It was recognized that such an adjustment would bias meat consumption measurements downward, particularly on beef and to a lesser extent on pork (Table 10).

The inclusion of deer, game birds and fish in the quantity series also caused substantial disturbances during the seasons when they were important. Since no expenditures were listed for these items the average price series for other meats, poultry, and fish would fluctuate with changing proportions of game. It was decided that all game items should be adjusted out of the data for this study.[9] For similar reasons gifts were subtracted, but this was a minor item.

The relative importance of locker purchases, gifts, and game, as related to annual meat consumption, is summarized in Table 10.

In working with the data, it became obvious that veal and lamb were purchased by a relatively small segment of the population. In any given week, only about three percent of the families were buying lamb or mutton and about eight percent

---

[9] Hereinafter the meat group referred t~~o~~as "other meats" will be labeled "sausage" since the adjustments leaves mostly franks, weiners, and assorted varieties of cold meats.

TABLE 10

QUANTITIES OF MEATS PURCHASED BY FAMILIES FOR THE YEAR JULY 1951 TO JUNE 1952, M. S. C. CONSUMER PANEL

Kind of Meat	Pounds per Family			
	Retail Purchases	Locker Purchases[a]	Other[b]	Total
Beef	125.34	9.46	1.54	136.34
Pork	135.08	4.63	1.53	141.24
Veal	10.74	--	--	10.74
Lamb or mutton	4.76	--	--	4.76
Other meats	52.19	--	5.02	57.21
Total red meats	328.11	14.09	8.09	350.29
Poultry	60.83	.93	4.02	65.78
Fish	23.18	--	4.13	27.31
Total all meats	412.12	15.02	16.24	443.38

a In February, 1954, 13 percent of the panel members either rented a locker or owned a home freezer. The quantity of meat purchased for locker storage is probably underestimated since it included only "large" individual purchases.

b Includes gifts, home grown and game. A substantial portion of deer is reported under other meats. Game birds are part of the fish total.

were buying veal. Under these conditions, the average price and quantity series were extremely erratic, reflecting week to week changes in the composition of these commodities. Because of this instability in the data and the relative unimportance of these items, veal and lamb were not included in subsequent analyses (Table 10).

Another problem that became apparent was that the classification of families on the basis of last year's income did not bridge smoothly from one year to the next. For example, on January 1, 1952, all families were reclassified into income groups based on 1951 income. In this process the dividing points were selected so as to shift a sizable number of families from the low to the medium income group and from the medium to the high income group. This did not become known until after the data for the first half of 1952 had been processed. Because of this difficulty, it was decided to consolidate the observations for the three income groups into overall averages for the entire panel. This process of aggregation also had the advantage of giving greater stability to some of the price series, particularly for the less important meat items.

Future studies should give attention to differences in income level as related to meat purchase patterns over time. An inspection of meat purchases by income groups indicated

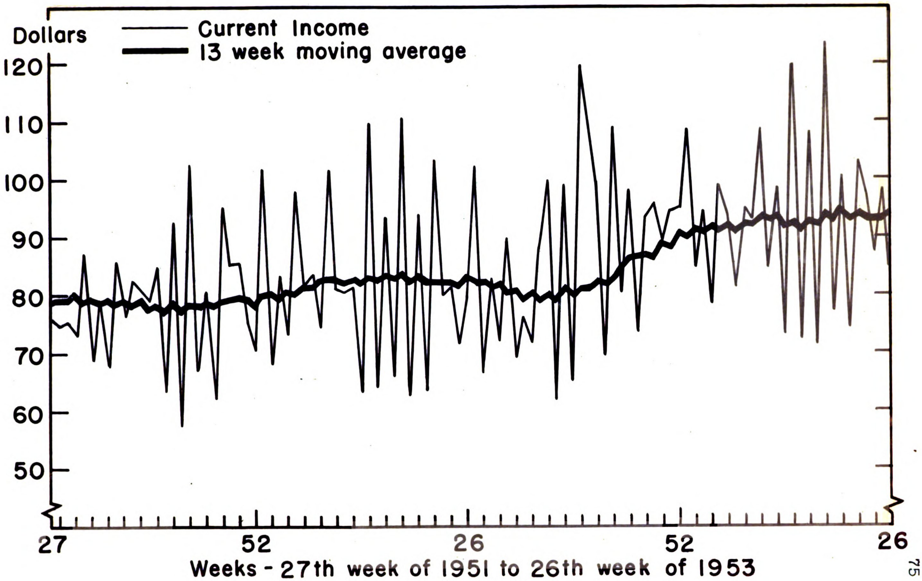


Figure IV. Average of weekly income reported by M.S.C. Consumer Panel families, July 1951 - June 1953.

that medium and high income families purchased more beef than low income families. However, part of the difference may have been due to differences in size of family. The graphs also showed the average price paid for pork was slightly lower for low income group as compared to the medium and high income groups.

A summary of "current" incomes of panel families showed wide variations from week to week (Figure IV). Each family reports its total income payment actually received during the diary week. (See page 15 of diary in Appendix). Part of the families are paid on a weekly basis while others are paid bi-weekly, monthly, or at irregular periods. The problem was to develop a time series of weekly observations that would reflect short term changes in current income. A simple average of weekly incomes reported by all panel families sometimes fluctuated from $65 to over $100 within a period of a month. It seemed unlikely that such an income series would be satisfactory as a variable in a multiple regression analysis designed to explain weekly meat purchases. However, it is recognized that meat purchases by individual families may be affected by the timing of pay periods. In an effort to smooth the income data, a four week moving average was computed using the current week's income and the incomes of the previous three weeks. This appeared to be much more satisfactory than the unadjusted series;

however, some irregularities still existed when monthly pay days fell outside the four week period. Consequently, it was decided that a 13 week moving average should be computed using the current week's income and incomes for the previous 12 weeks (Figure IV). The use of a lagged moving average, instead of a centered moving average, implied that the income already received had more effect on meat purchases than the anticipation of future income. In some instances this may be questionable, but for the majority of the cases the lagged relationship seems more appropriate since a relatively small proportion of the meat is sold on credit basis.[10]

Limitations of the Data

In addition to the problems mentioned above, certain limitations of the data should be recognized. One of the more obvious limitations was that the retail prices of beef were under the control of the Office of Price Stabilization from May 1951 until February 1953. During the later portion of 1951 and the first half of 1952, the prices of most retail beef cuts hovered near ceiling levels. Later in 1952, prices declined below the ceiling for many beef items. There was

---

[10] A survey of 1,351 retail meat stores in the North Central Region in May 1953, revealed that 24.3 percent of the total meat sales were on a credit basis.

little to indicate that any real "shortage" of beef occurred in retail stores in Lansing during the price control period. (See Chapter VI for a more complete statement on the effect of OPS controls on beef).

Another limitation of the panel data was that the segregation of beef purchases by grades was impossible. There was little that could be done about this since it is believed that most housewives are unable to identify and report beef purchases by grade. Furthermore, with the elimination of compulsory government grading, a substantial portion of the beef carries one of many packer grades or no grade identification at all. Even in stores carrying graded beef, the identification stamp is frequently removed in the process of breaking wholesale cuts into retail cuts.

The non-homogeneity of products from week to week probably leads to some "false" changes in the prices of these items due to method of computing the average price series. Nevertheless, there are practical limitations on the amount of detail that can be gotten on food items purchased for home consumption.

Undoubtedly there are errors in the reporting of purchases. Since meat is a major item in the food budget, it is believed that errors due to omission of purchases are relatively unimportant. There is some reason to believe that some of the veal purchases are being reported as beef and that hams and picnic hams are sometimes confused by panel members.

Page 79 lacking in numbering only.

UNIVERSITY MICROFILMS

Level and Pattern of Meat Consumption

Per capita purchases of all meats for home consumption by the M.S.C. Consumer Panel were 15 percent less than the per capita meat consumption estimated for the United States for the year July 1951 to June 1952 (Table 11). Red meat purchases by panel members were11.4 percent below the U.S. average.

The differences between panel purchases and U.S. average consumption estimates might be attributed to some of the following reasons: (1) the panel quantity series do not include meat eaten away from home as snacks or as part of meals eaten out; (2) the estimates for U.S. average consumption may be in error or may not be comparable in terms of retail weight equivalents.

It is believed that the first reason is the most important. An examination of the data reveals that panel families spent 12½ percent of their total food bill during 1952 for meals eaten out. This does not include snacks, such as hamburgers and hot-dogs. A recent study in Minneapolis, Minnesota, indicated that about 16 percent of all food (valued at retail prices) was passing through public and private eating places and institutions.[11] "A slightly higher proportion (22 percent) of the total value of meat, sea food, and poultry was

---

[11] Lester C. Sartorius and Marguerite Burk, Eating Places as Marketers of Food Products, Bur.Agr.Econ., U.S.Dept. of Agr. in cooperation with the Univ. of Minn., Marketing Research Report No. 3, 1952, p.89.

marketed through eating places, apparently because of the greater emphasis on meats in eating places, particularly in the higher priced ones."[12] Generalizing from the above observations it seems reasonable to conclude that total meat consumption by M.S.C. Panel families was greater than the U.S. average consumption when proper allowance is made for meat eaten away from home.

It is doubtful that the panel estimates of meat consumption are biased downward appreciably. The extremely high income segment of the population is not well represented in the panel, but on the other hand, neither are the extremely low income families. There is reason to believe that the average consumption estimates are fairly representative of the true population parameters.[13]

There is some reason to believe that the U.S. average consumption figures for meats may be biased upward. The original estimates were in terms of wholesale carcass weight equivalents. These were converted to retail weights by using the following conversion factors:[14]

Beef	.79
Pork, excluding lard	.93
Veal..................	.91
Lamb and mutton.....	.89

---

[12] *Ibid.*, p.88.

[13] This was developed on page 65.

[14] Bur. of Agr.Econ., U.S.Dept. of Agr., *Consumption of Food in the United States*, Agricultural Handbook No. 62, 1953, p.133.

TABLE 11

MEAT CONSUMPTION BY M.S.C. CONSUMER PANEL COMPARED TO U.S. AVERAGE, JULY 1951-JUNE 1952

Kind of Meat	Pounds Per Capita			Panel as Percent of U.S.Average
	United States		M.S.C.Panel	
	Carcass Weight[a]	Retail Weight[b]	Retail Weight[c]	
Beef	56.5	44.6	41.6	93.3
Veal	6.5	5.9	3.3	55.9
(Beef and veal)	(63.0)	(50.5)	(44.9)	88.9
Lamb and mutton	3.7	3.3	1.2	36.7
Pork (excluding lard)	71.7	66.7	43.1	64.6
Sausage	--	--	17.4	--
Total red meats	138.4	120.5	106.8	88.6
Poultry	27.2	27.2	20.1	73.9
Fish	11.1	11.1	8.3	74.8
Total all meats	176.7	158.8	135.2	85.1

a Based on quarterly estimates of red meat consumption as reported in The Livestock and Meat Situation, U.S.Dept. of Agr., Agr.Mkt.Ser., January 1954, p.7.

b Based on conversion factors used in Consumption of Food in the United States, 1909-52. U.S.Dept.of Agr., Bur. of Agr.Econ Agr. Handbook No.62, 1953, p.133.

c Based on total quantities reported by M.S.C.Panel members. The "sausage" grouping includes all luncheon meats, franks and processed meats where beef, pork, etc., lose their identity. Therefore, the Lansing retail weights are not directly comparable to the U.S. averages.

The conversion factors for beef and pork may be appropriate for portions sold as fresh cuts, but it is doubtful that ample allowance has been made for weight losses for cured and processed items. Weight losses, due to shrinkage and deterioration in the retail store, probably amounts to about 5 percent of wholesale weights.[15] A tentative conclusion is that the U.S. average consumption figures used in this study probably overestimate actual weights purchased by consumers.

A general conclusion at this point is that total meat consumption by the M.S.C. Consumer Panel families is greater than the U. S. average. This would be expected since the income level of Lansing families was about one-third above the U.S. average based on the 1950 Census. (See Table 6). A recent study of regional variation in red meat consumption showed that the North Central Region was 6 percent above the U.S. average based on 1944 data compiled from records of the Office of Price Administration.[16] The 1948 Food Consumption Surveys, made by the BHNHE of the U.S. Department of Agriculture, indicated that consumption of red meats by urban persons exceed the U.S. average by 22 percent on beef, 2 percent on pork, and 31 percent on lamb and mutton.[17]

---

[15] National Livestock and Meat Board, Pricing Retail Meat Cuts, p.13.

[16] J.C.Purcell and V.John Brensike, Net Marketing and Slaughter of Livestock and Consumption by Regions, 1950, Bur. of Agr.Econ.,U.S.Dept.of Agr.,preliminary manuscript.

[17] U.S.Dept.of Agr.,Family Food Consumption in the United States, 1942, Miscellaneous Publication No.550, 1944.

The above discussion centered around the reconciliation of the differences in levels of meat consumption between the M.S.C. Consumer Panel and the United States averages. A question might also be raised about the pattern of consumption among the different kinds of meats. According to Table 12, the Lansing pattern is very similar to that found in the North Central Region during the 1948 Food Consumption Survey. In both cases, lamb and mutton consumption is extremely low, being only a little more than one-third of the national average. The proportion of beef and veal is relatively larger in the 1948 study than in the Lansing panel data for 1951-52. This is probably due to shifts in relative supplies and prices of pork and beef between the two periods. In both periods, beef and veal consumption exceeded pork consumption. In general, the pattern of meat consumption in the panel seems to compare quite closely with the results of previous studies.

Lansing Prices Compared to Detroit BLS Prices

Since the price series derived from the panel data were weighted average prices obtained by dividing total expenditures by total quantities, some question may exist as to whether these prices accurately reflect price changes in the retail stores. Several comparisons of panel prices for the Lansing market with prices for similar commodities, reported

TABLE 12

CONSUMPTION PATTERN FOR RED MEATS IN LANSING COMPARED TO PATTERNS FOR THE NORTH CENTRAL REGION AND THE UNITED STATES[a]

Place	Beef & Veal	Pork	Lamb & Mutton	Other	Total Meat
	Percentages Based on Panel Data[b]				
Lansing	42.0	40.3	1.4	16.3	100.0
	Percentages Based on 1948 Survey[c]				
United States	43.7	36.7	4.3	15.3	100.0
North Central Region	43.5	38.1	1.5	16.9	100.0
	Percentages Based on OPA Records for 1944				
United States	49.3	47.9	2.8	--	100.0
North Central Region	48.9	50.2	0.9	--	100.0

a All data, other than for Lansing, taken from "Net Marketings and Slaughter of Livestock and Consumption by Regions, 1950, preliminary report by J.C.Purcell and V.John Brensike, Bur.of Agr.Econ.,U.S.Dept.of Agr.

b M.S.C.Consumer Panel, July 1951 to June 1952.

c 1948 Food Consumption Surveys conducted by the Bureau of Human Nutrition and Home Economics, U.S. Department of Agriculture.

by the Bureau of Labor Statistics for Detroit, have been made. Direct comparisons are difficult because the BLS price series are quoted for specific retail meat cuts.[18] For beef items, U.S. Choice and U.S. Good, grades are the basis of reporting. The panel price series are for fairly broad groups of retail cuts with no grades specified. The BLS prices are taken by market reporters, who make the rounds of sample stores during the first three days of the week, during which the 15th of the month falls. The panel prices are based on purchases over the entire week and therefore, are more likely to reflect the influence of meat price specials featured during late week trading when more than one-half of the meat is purchased.

Since there is considerable difference in the definition of the retail cuts involved in the two price series, a comparison of the level of prices probably is of little significance for most cuts. More important is a comparison of price trends over time for similar items. Such a comparison has been made graphically and by correlating the pairs of price series.

Figure V shows a graphical comparison of retail prices for beef items. The prices of ground beef moved together very closely, with a correlation of .98. The prices for roasts and steaks showed similar patterns, with the Detroit price declining less rapidly than Lansing prices. The wide difference in

---

18. Bur. of Labor Stat., U.S. Dept. of Labor, Food Pricing Specification Manual, January 1954.

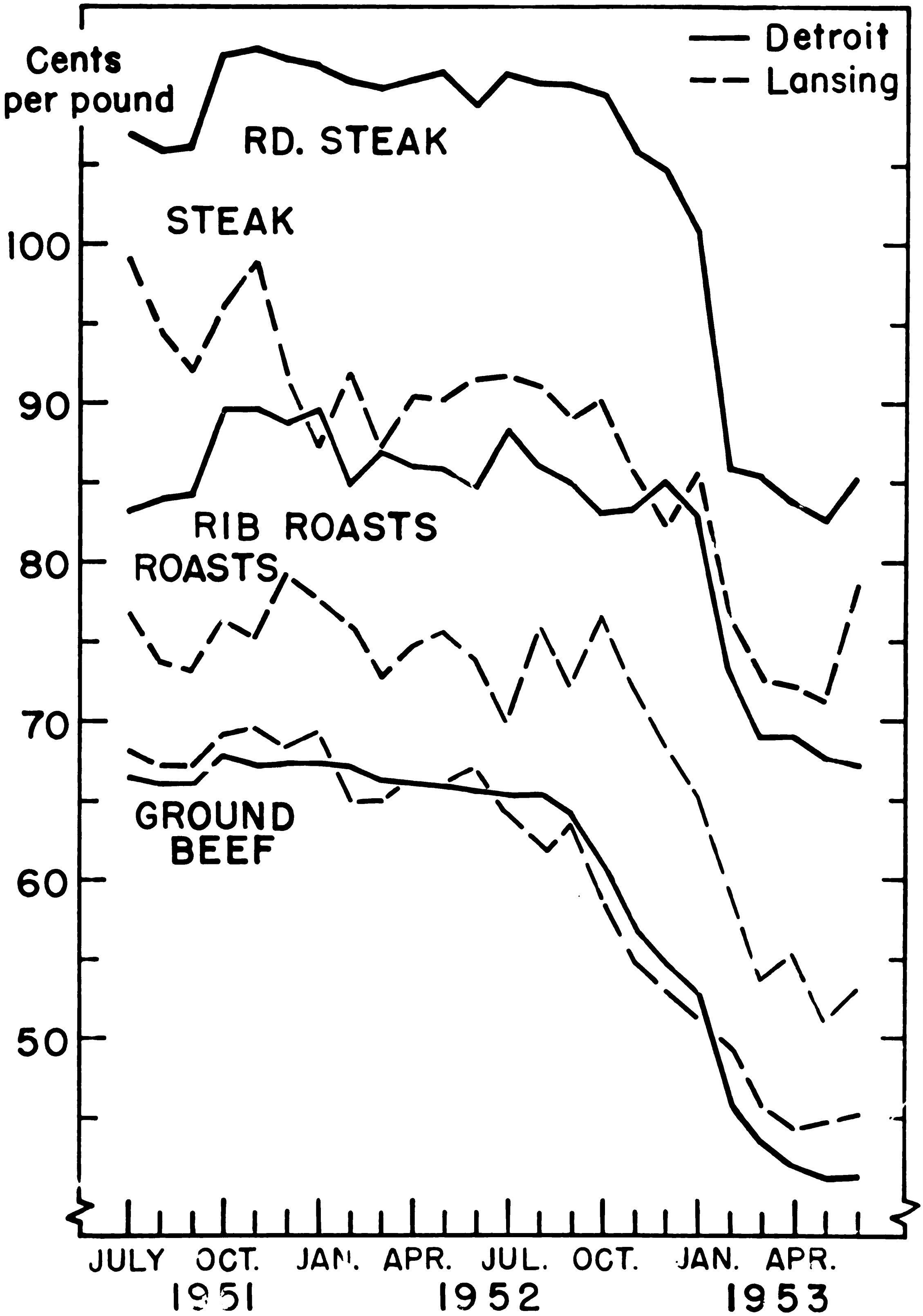


Figure V. Comparison of Lansing M.S.C. Consumer Panel prices and Detroit B.L.S.prices for selected cuts of beef, July 1951-June 1953.

level of prices is due largely to the differences in the grade of beef. The BLS series specified U.S.Choice and U.S. Good grade in rib roasts, while the Lansing price is an average for all kinds and grades of roasts. The BLS series also specifies U.S. choice and U.S.Good round steak, while the Lansing price represents all kinds of steak. The correlation between steak prices was .85, and between roasts and rib roasts it was .92.

Figures VI and VII, show a graphical comparison of prices for selected pork cuts. The prices on pork chops moved together fairly well with differences in price level again due to the item specifications. For the BLS price only center cut pork chops from No.1 loins are represented. Rib ends or shoulder ends or should end chops and soft or oily pork was excluded. The Lansing price represented all kinds and qualities of chops. The correlation between the two price series was .80.

The correlation between bacon prices was .89 with the BLS price representing sliced and packaged, one pound units of Standard Grade A bacon.

Although ham prices tended to follow the same general pattern, there were much wider variations in the Lansing price series than in the Detroit prices. The correlation between the two series was .40. The BLS specification calls for skin-

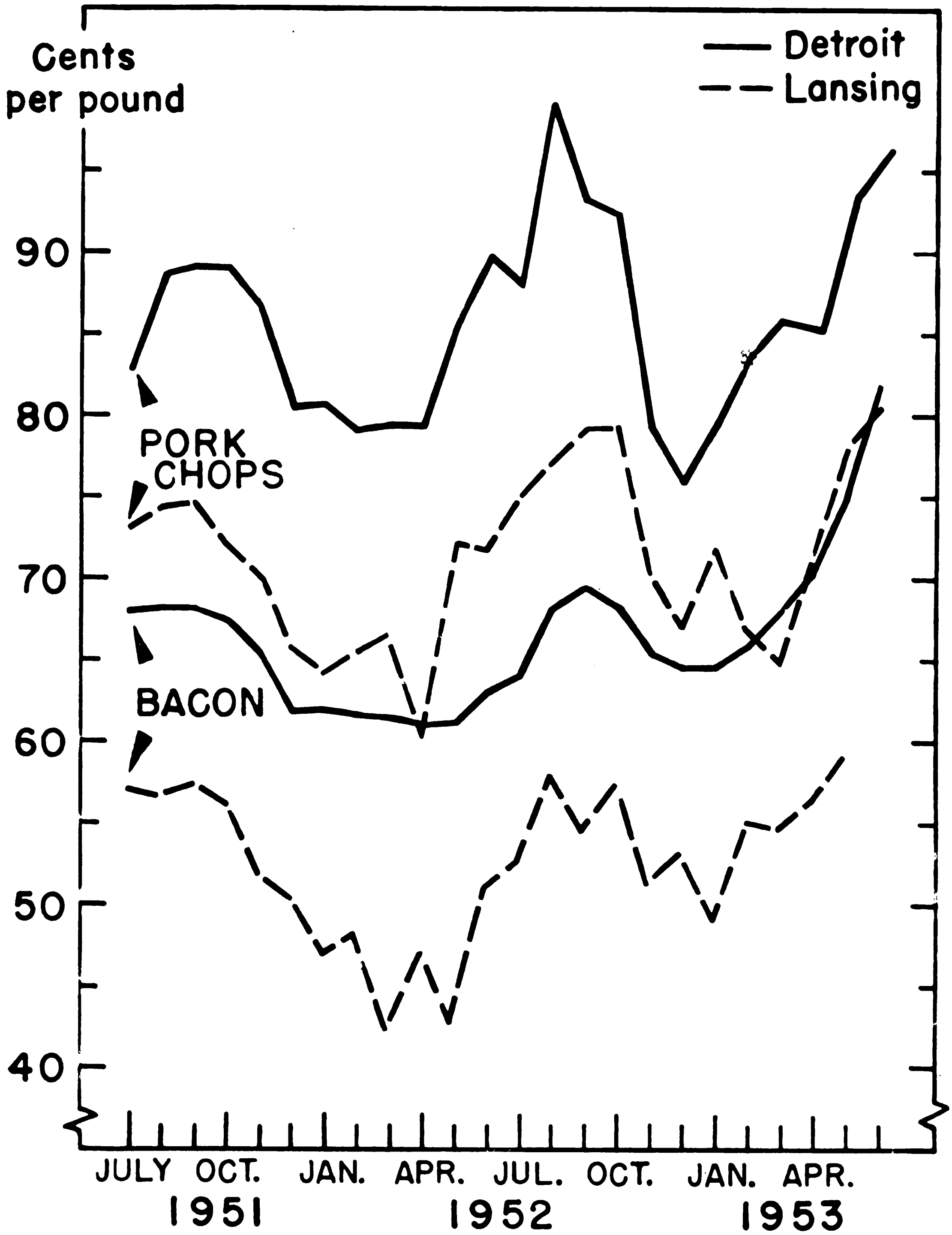


Figure VI. Comparison of Lansing M.S.C. Consumer Panel prices and Detroit B. L.S. prices for selected cuts of pork, July 1951-June 1953.

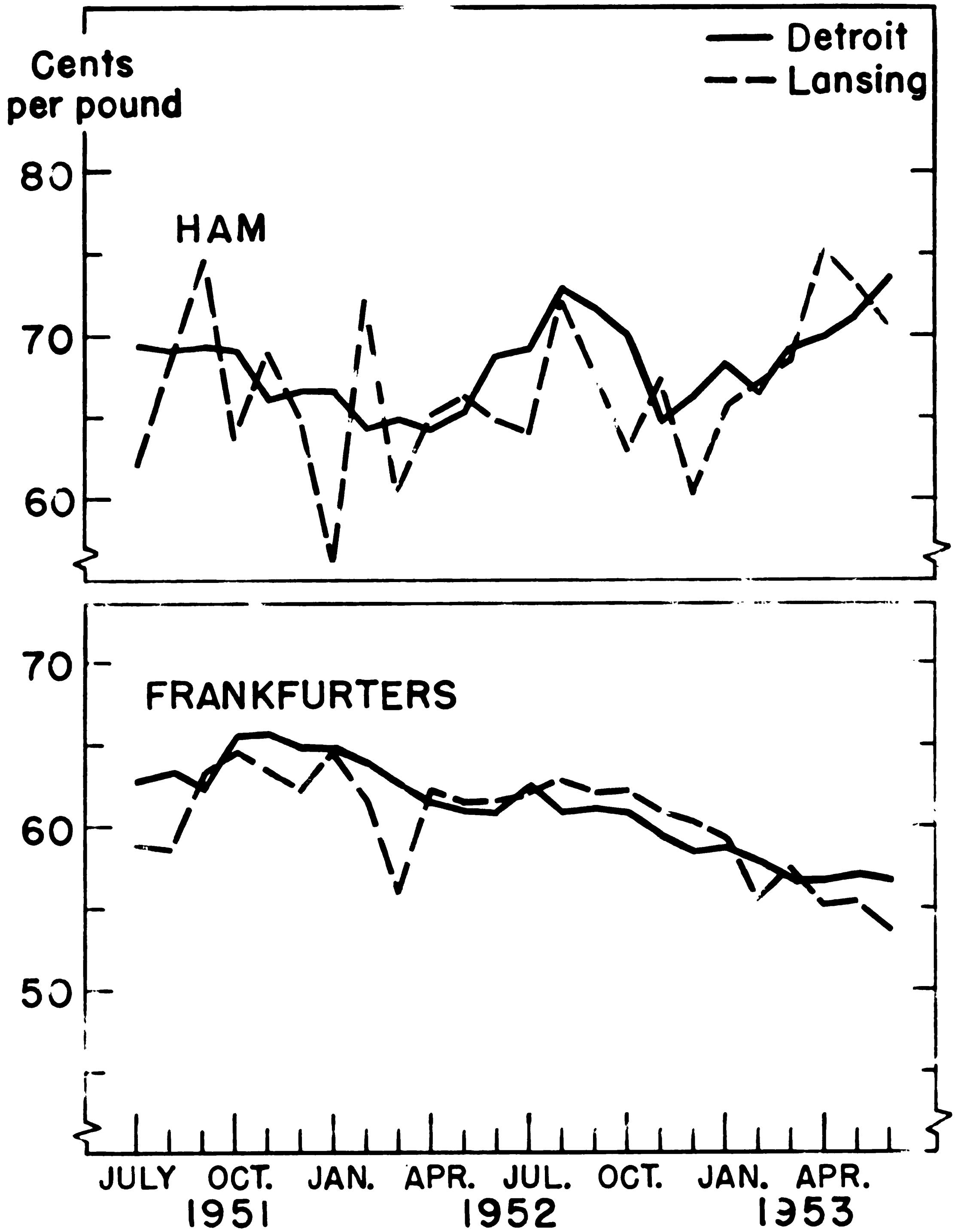


Figure VII. Comparison of Lansing, M.S.C. Consumer Panel prices and Detroit B.L.S. prices for ham and frankfurters, July 1951-June 1953.

ned, smoked, tenderized ham weighing between 10 and 16 pounds and of the "best quality." The Lansing price probably reflects to a greater extent the impact of "specials" on whole or half hams.

The prices of frankfurters (includes almost all types of weiners) were closely related with few exceptions. A correlation of .74 existed between the Detroit and Lansing prices.

In conclusion, it appeared that Lansing prices derived from panel data displayed a close relationship to Detroit BLS prices when allowance is made for differences in commodity specifications. The major price changes are reflected in both sets of prices; however, the Lansing prices showed more variability. Presumably this variation in Lansing prices reflected more of the effects of "specials" and to some extent changes in commodity composition from one period to another.

CHAPTER V

SINGLE EQUATION DEMAND MODELS FOR GROUPS OF MEATS

Introduction

This chapter deals primarily with the problems encountered in formulating the single equation models used in measuring demand for meat groups.

The food purchase diary for collecting data from panel members and the basic IBM tabulating procedures were accepted as relatively fixed elements in constructing the demand equations. The measurement of demand for broad groups of meats, such as beef and pork, received the most attention because these data became available at an earlier date than the more detailed data for specific meat cuts, such as beef roasts and pork chops.

Although the demand equations were relatively simple, several problems arose with respect to the length of the time period for individual observations, the choice of variables to be included in the system, the handling of disturbances such as holidays and changes in demand, and the specification of the mathematical functions to be fitted.

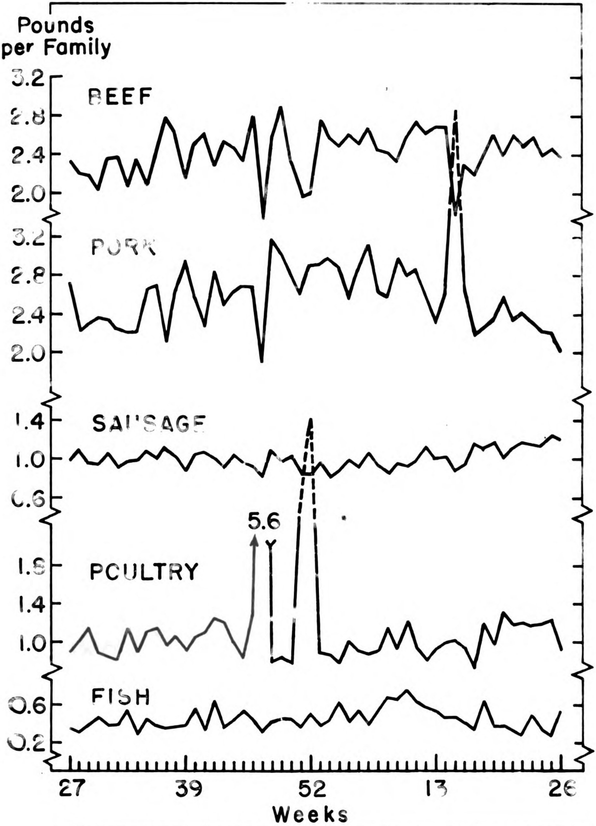


Figure VIII. Weekly average purchases of different kinds of meats by families, M.S.C. Consumer Panel July 1951-June 1952.

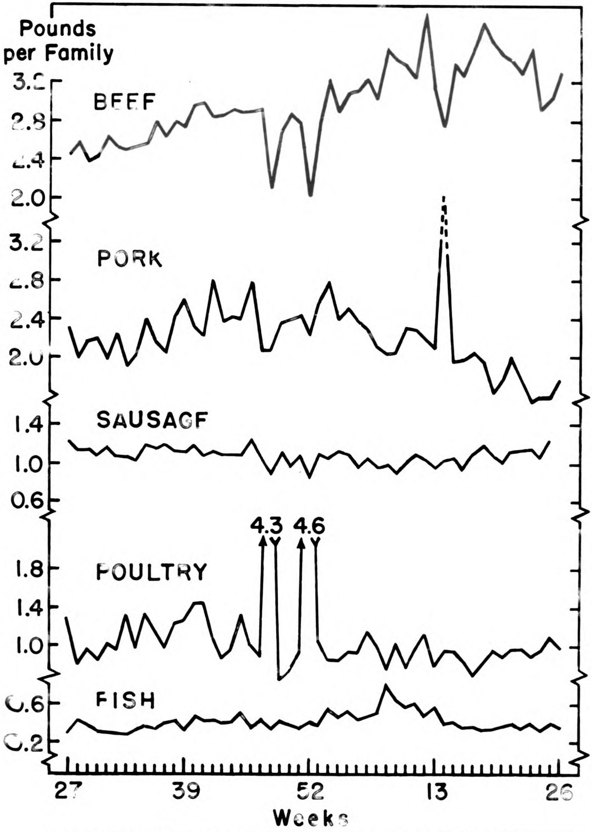


Figure IX. Weekly average purchases of different kinds of meats by families, M.S.C. Consumer Panel, July 1952-June 1953.

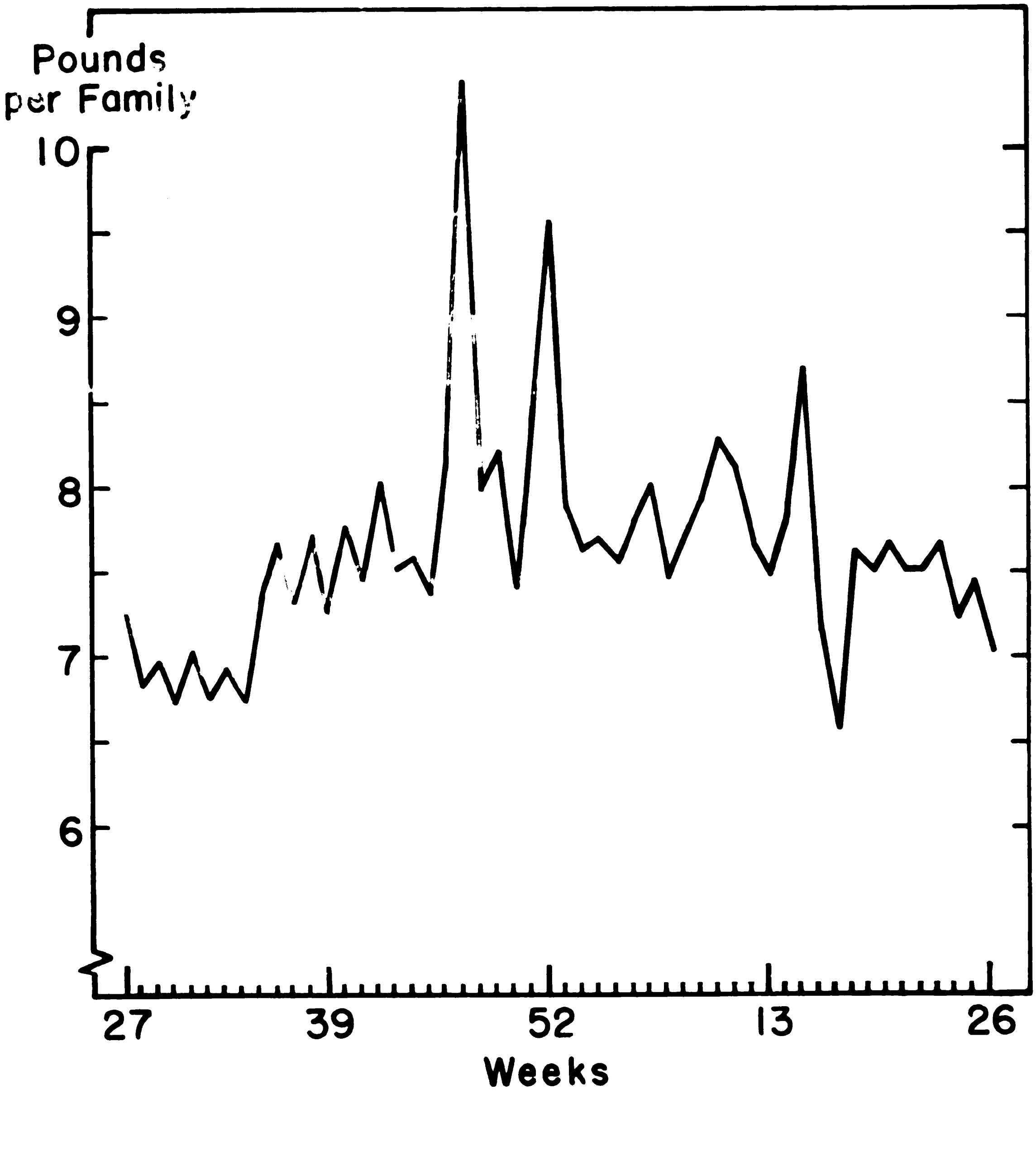


Figure X. Weekly average purchases of all meats by families, M.S.C.Consumer Panel, July 1951-June 1952.

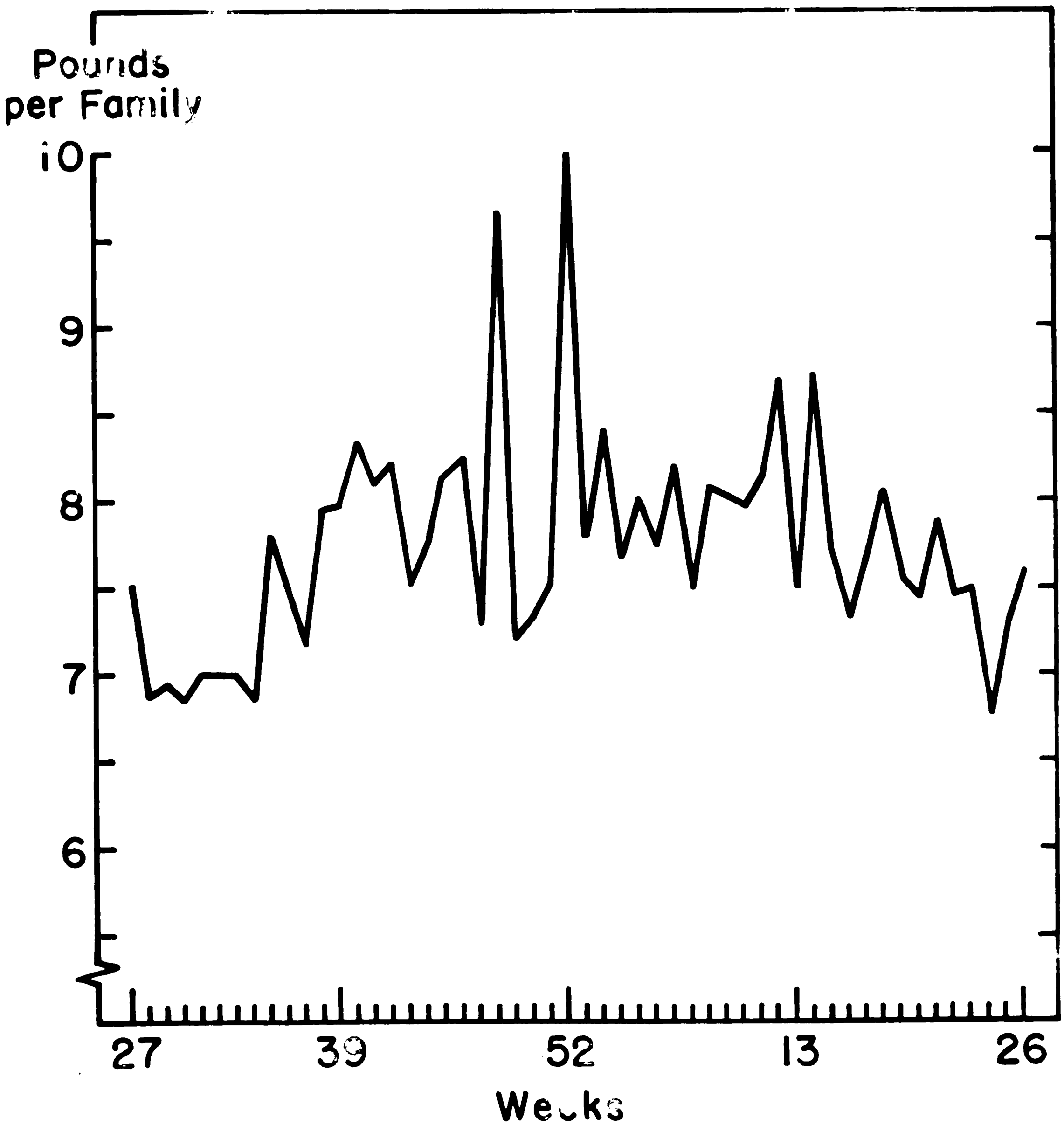


Figure XI. Weekly average purchases of all meats by families, M.S.C.Consumer Panel, July 1952-June 1953.

Evaluation of Weekly Observations

Panel members report their food purchases on a weekly basis. It is possible, however, to aggregate weekly observations for pusposes of analysis. An examination of week-to-week variations in quantities of meats purchased revealed that sizable fluctuations had occurred. (See Figures VIII, IX, X, and XI.)

If the week-to-week variations were largely due to instability because of the small size of the sample, the combining of several weekly observations would tend to reduce the period-to-period fluctuation. It should increase the multiple correlation coefficients for the demand equations but might have little effect on the regression coefficients as compared with equations based on weekly observations.

A question might also be raised about the amount of time which consumers require to make adjustments to changes in retail food prices. If this requires several weeks or months there might be reasonable doubt that weekly observations represent "true" equilibrium adjustments in the static sense. Still another argument that might be raised against the use of weekly observations is that statistical difficulties with autocorrelation may be greater than when using data based on monthly or annual observations.[1] Additional explanatory

---

[1] Lawrence R. Klein, Econometrics. Row, Peterson and Company, Evanston, Illinois, 1953, p.317.

variables may be required to allow for lagged relationships.

There are, however, some strong arguments for the use of weekly observations. One argument is that retailers adjust meat prices on a weekly basis.[2] Each week different meat items are featured as specials. Another argument for the use of weekly observations is that most families shop weekly, or more often, for meat. In any given week about 80 percent of the M.S.C. Consumer Panel families buy some kind of beef and about 75 percent purchase pork in some form. This is expected in view of the perishability of most meat items and the importance of the meat dish in meal planning.[3] Another factor considered was that aggregating weekly data into longer time periods would have greatly reduced the number of degrees of freedom in applying regression analysis. This is not to say, however, that the amount of information lost in the aggregation process is directly proportional to the reduction in the number of degrees of freedom.[4] Last, but still of considerable

---

[2] For a recent example of short-term adjustments in retail meat prices, see Marketing Margins for Beef, U.S. Dept.of Agr., Agr.Mkt.Ser., December, 1953. See also: Kenneth D. Naden and George A. Jackson, Some Economic Aspects of Retailing Chicken Meat, California Agr. Exp. Sta. Bul. 734, 1953. pp.41-42.

[3] An RMA study now under way at Harvard University should provide some additional information on this point.

[4] Klein, op.cit., pp.313-314.

importance, is the consideration that little empirical evidence has been available on consumer meat purchases on a weekly basis. An analysis of these shorter run adjustments would provide some additional information not available previously. For these reasons most of the analysis in this study will deal with weekly observations.

Principal Variables to be Included in the Models

Subject matter considerations suggest that the quantity variable should be taken as dependent in the single equation models used to explain weekly meat purchases of families in the M.S.C. Consumer Panel. In any given week, these families step up to the retail meat counters to make their purchases, accepting as fixed the price tags appearing on the different cuts of meat. The quantities purchased by these families can be considered as their response to the price structure confronting them along with the many other complex forces which motivate these consumers to buy.

This raises a question as to which variables should be included in the equations explaining the variations in weekly purchases of different groups of meats. Some restrictions on choice of variables are imposed by the availability of data and the increasing complexity of computations as more and more variables are added to the model. The variables which theory indicates as most important are: (1) price of product being studied, (2) prices of closely related products, and (3) available income of the purchasers. Following this pattern, the demand for a particular meat group such as beef can be represented by the following functional relationship:

$$Q_{beef} = f\,(P_{beef},\ P_{pork},\ P_{sausage},\ P_{poultry},\ P_{fish},\ I)$$

where Q is the average quantity purchased per family per week, P is the city-wide average price, and I is a measure of average family income.

The relative importance of these different groups of meats was pointed out in Table 10, page 73. Because of the small quantities purchased, lamb and veal were excluded from the analysis. There is some question about the inclusion of fish; however, it was decided to leave it in initially so as to have a more complete coverage of meat items. Eggs might have been included, but it was reasoned that they were primarily a breakfast item and hence did not compete directly with most meat products.

Other Variables Affecting Weekly Meat Purchases

Holidays and religious customs. An inspection of fluctuations in weekly purchases of different kinds of meats, as shown in Figures VIII and IX, indicates that the simple model shown above is probably inadequate to account for the wide

variations observed. The most noticeable disturbances occur in conjunction with the major holidays, Thanksgiving, Christmas, and Easter. Due to customs developed over the years, Thanksgiving and Christmas are holidays when poultry meats are traditionally served. At Easter ham has become the popular item. These holiday customs cause tremendous shifts in the demand functions for all kinds of meats (Table 13).

During Thanksgiving week 1952, purchases of poultry meats were over 300 percent above the average level of weekly purchases for the rest of the year (Table 13). Purchases of all other meat groups averaged about 15 to 20 percent below the yearly average. Even so, total meat purchases were 28 percent above average. Not only were there sizable shifts in quantities purchased, but changes also occurred in prices. The average price of poultry meats advanced about seven cents per pound. This is probably due to a change in the average composition of this group of meats, with a larger than usual proportion being higher priced roasting fowl. The price of fish was about seven cents higher than usual; the increase being due to a larger than normal proportion of high priced oysters and other seafood delicacies.

Poultry is also the most popular meat at Christmas, with ham coming in as a preferred item during the Christmas-New Year's holiday period. Total meat purchases exceeded the yearly average by about the same amount as observed during

TABLE 13

AVERAGE PURCHASES OF MEAT DURING HOLIDAY WEEKS COMPARED WITH AVERAGE WEEKLY PURCHASES FOR THE REMAINDER OF THE YEAR, M.S.C. CONSUMER PANEL, 1952

Kind of Meat	Thanksgiving Week		Christmas Week		Easter Week	
	Pounds per Family	Percent of Average*	Pounds per Family	Percent of Average*	Pounds per Family	Percent of Average*
Poultry	4.28	404	4.57	444	1.04	98
Beef	2.10	80	2.02	77	1.78	68
Pork	2.06	85	2.22	91	4.54	188
Sausage	.90	86	.78	73	.87	84
Fish	.33	76	.40	93	.47	112
All meat	9.67	128	9.99	132	8.70	115

* Average weekly purchases for 1952 with holiday weeks omitted.

Thanksgiving (Table 13). During 1951, the Christmas-New Year's food shopping was divided between two different weeks, making it difficult to combine the data with those of 1952 to arrive at some sort of average (Figure VIII).

Due to extensive promotional efforts of the meat trade, ham has become the favorite meat item at Easter. In 1952, ham promotions boosted total pork purchases to 88 percent above the average for the rest of the year. In 1953, pork sales rose much less at Easter than in 1952 (Figure IX). This was probably due largely to the sharply lower beef prices and somewhat higher pork prices in 1953 as compared with 1952. In 1952, the average price of beef was 75 cents per pound while pork sold at 54 cent at Easter. By Easter week 1953, beef prices had fallen to 58 cents and pork had risen to 62 cents per pound. Another point of interest about the effects of Easter is that pork sales tend to be depressed for a week or two after the holiday. Since ham is storable for two to four weeks in an ordinary refrigerator, the large sales at Easter appear to be partially at the expense of pork sales and total meat sales for a short time after the holiday (Figures VIII and IX).

Another disturbance, similar in nature to the holiday situations just discussed, is the effect of the Lenten period on meat purchases. In 1952, Lent began during week 9 and lasted until week 15. In 1953, it began during week 8 and ended with week

14. The effects are most noticeable in the pattern of fish and seafood purchases, with substantial increases being particularly marked in the first two or three weeks of the Lenten period (Figures VIII and IX). Lent lasts about six weeks in all and ends on Easter Sunday. In total, the curtailment of meat purchases by those families who abide by the Lenten customs does not appear to have a very significant influence on total meat purchases of the M.S.C. Consumer Panel (Figures X and XI).

Thanksgiving, Christmas-New Year's, and Easter appear to be the major holiday periods influencing demand for meats. Other widely observed holidays, such as Memorial Day, Independence Day, and Labor Day, do not appear to be associated with noticeable shifts in meat purchases. (See Table 13 and Figures VIII, IX, X, and XI.) A question may arise in regard to Labor Day because a sizable upward shift in meat consumption tends to occur about this time of year. In 1951, this upward adjustment occurred during the week following the Labor Day weekend, while in 1952 it coincided with the Labor Day weekend. Further consideration will be given below to this seasonal increase in meat purchases. At this point the tentative conclusion would be that Labor Day in itself probably has only a minor effect on meat purchases.

In constructing the single equation demand models, some provision must be made for shifts in demand due to the holi-

TABLE 14

WEEKS OF THE CALENDAR YEAR DURING WHICH HOLIDAYS OCCURRED AND THE DAY OF THE WEEK UPON WHICH THE HOLIDAYS FELL, JULY 1951 - JUNE 1953*

Holiday	1951		1952		1953	
	Week	Day	Week	Day	Week	Day
New Year's Day			1	Tuesday	1	Thursday
Easter			16	Sunday	15	Sunday
Memorial Day			22	Friday	22	Saturday
Independence Day	27	Wednesday	27	Friday		
Labor Day	35	Monday	36	Monday		
Thanksgiving	47	Thursday	49	Thursday		
Christmas	52	Tuesday	52	Thursday		

* The diary week begins on Sunday and ends on Saturday. When holidays occur on Sunday, such as Easter, the effects on food purchases are noted in the preceding week.

day disturbances discussed above. One alternative would be to omit from the analysis weeks involving major holidays. Another possibility would be to add a separate explanatory variable to each equation with zero for all observations except the holiday week, where a value of one would be inserted. The coefficient of the holiday variable would then provide an estimate of the influence of the holiday disturbance.

A third alternative would be to construct a holiday variable with each holiday being given a value approximating its effect in shifting the demand function. The influence of the holiday might be approximated roughly by the deviation of holiday purchases from a regression line of quantity on price for a particular meat. This procedure would not take into account the effects of price and quantity changes among competing meats. An estimate of the relative influence of the holiday disturbances could also be taken from the results of the second procedure suggested above, where a separate explanatory variable is included for each of the major holidays.

Seasonal shifts in demand. A similar seasonal pattern of meat purchases appears during both of the years for which panel data are summarized. As might be expected, purchases of "all meats" are smaller during the summer and larger during the fall and winter months (Figure X and XI). Pork purchases exhibit greater seasonal variation than any of the other major groups (Figure VIII and IX). The patterns of purchases for both beef and pork are similar to that just described for all meats. However, the patterns of purchases of beef and pork for the year, July 1952 to June 1953, are distorted by substantial cyclical changes in prices of these meats, which in turn are the result of shifts in supplies offered on the national market.

Although seasonal variations are not large, purchases of sausage meats tend to follow a pattern different from the patterns of beef and pork purchases. Sausage items are purchased in slightly larger volume during the summer months as compared with other seasons of the year (Figures VIII and IX).

Poultry purchases appear to have no well-defined seasonal pattern except the holiday variations already described. Fish purchases are highest during Lent and lowest during the rest of the spring and summer.

A large portion of the seasonal variation in total supplies and prices of beef and pork is due to rather well-established seasonal fluctuations in livestock slaughter. Beef slaughter rises in volume during the fall as cattle are marketed off pastures. Hog slaughter also rises rather steadily from late August through November as the spring pig crop moves to market. Variations in fresh meat supplies are closely associated with corresponding seasonal price variations at the wholesale level.[5] These price changes are soon reflected in retail prices as supplies increase and decrease. An examination of the panel data revealed that a major portion of the seasonal variation in purchases was associated with corresponding adjustments in meat prices.

A question which requires consideration is the extent to which seasonal variations in meat purchases are due to shifts in the demand function. There is considerable evidence that demand for "all meats" and "all food" actually declines during the summer months.[6] High temperatures tend to retard food intake and cause shifts in demand among different food items. Among the meat items, ready-to-eat cold meats and easily prepared steaks and chops gain in popularity, while heavy roasts and stewing items are less desired.[7] This preference pattern is again altered as cooler weather arrives in the fall.

Selected excerpts, from weekly wholesale meat trade reports, lend further support to the notion that demand for

---

[5] F. L. Thomsen and R. J. Foote, Agricultural Prices, McGraw Hill, New York, 1952, Chapters 19 and 20.

[6] Bur. of Human Nutr. and Home Econ., U.S.Dept.Agr. Seasonal Patterns of Food Consumption, City Families, 1948. Special Report No.3, February 1951, p.1

[7] A. A. Dowell and Knute Bjorka, Livestock Marketing McGraw Hill, New York, 1941, p.48.

fresh meats declines during the summer:[8]

> July 4, 1953, Chicago: "With narrow consumer outlets, due primarily to hot, humid weather, trading during the week was dull and most sales forced."
>
> July 4, 1953, New York: "The impending holiday and the beginning of family vacations were factors contributing to a relatively slow trend."
>
> July 14, 1953, Chicago: "Demand for most classes of fresh meat showed a considerable improvement over the previous week with more normal temperatures a stimulating factor."
>
> August 25, 1953, Chicago: "Sparked by cooler temperatures demand for fresh meat improved materially."
>
> September 8, 1953, Chicago: "Trading was marked by a series of slow, mostly forced sessions with the market in all classes and cuts very unsettled. Exceedingly high temperatures curtailed consumer outlets and proved a depressing factor in the meat trade."
>
> September 15, 1953, Chicago: "Demand for fresh meat showed considerable improvement with cooler weather a stimulating factor."

These comments suggest that extremely hot, humid weather reduces consumer demand for fresh meat, and that the advent of cooler weather in late summer and early fall has a stimulating influence on appetites which increases demand for meat. In addition to the effects of extremely high summer temperatures, it seems that the irregular pattern of living activities interspersed with vacations, picnics, and travel, con-

---

[8] These excerpts are taken from the Weekly Livestock Market News report entitled "Market News and Statistics," issued by the Livestock Branch, Production and Marketing Administration, U.S.Dept. of Agr., Washington, D.C.

tributes to a reduced demand for fresh meats and many of the heavier foods. With the reopening of schools on, or about, September 1, and the end of the vacation period, more regular food habits are resumed and demand for fresh meat probably increases significantly.

No satisfactory method of allowing for these seasonal shifts in demand was arrived at during the early stages of this investigation. It was decided that a close examination of the residuals from the basic equations, outlined earlier in this chapter, might be the best approach to the problem. The pattern of the residuals might yield an approximation of the magnitude and timing of the shifts in demand for different meat groups, realizing, of course, that other disturbances were likely to be compounded in the residual patterns. Another alternative would be to try to add temperature as an additional explanatory variable. Still another possibility would be to segregate the summer period and analyze it separately; but the short period over which data were available made this rather impractical.

Merchandising activities of retailers. It must be recognized that there are several methods that managers of individual retail stores use to influence meat purchases in their particular stores.[9] One method is advertising in conjunction

---

[9]Naden and Jackson, op.cit., pp.50-70.

with a price reduction on selected meat items to attract customers into their stores. Once in the store, the customers are likely to be influenced in their purchases by point-of-sale promotional material and by the location and amount of space allocated to different items in the display. In stores with service meat departments, the customer can also be influenced by the sales talk of the butcher. When an item is out of stock, the butcher is always ready to push some other item that happens to be long in supply.

When attempting to explain weekly average purchases of meats by the M.S.C. Consumer Panel, there is a strong possibility that many of these merchandising practices cancel out, because all stores are not likely to be using the same promotional schemes in any given week. Nevertheless, it must be recognized that the effect of advertising is not likely to be a random disturbance from week to week. In the first place, when one of the major chain stores features a special on a large traffic item, such as ground beef or chuck roasts, a mark-down of ten cents a pound may affect nearly 10 percent of the total sales of these items in a given week for the entire city. In an effort to meet competition, other stores will feature specials, frequently on the same item or a closely related item. In some weeks when several of the large chains feature specials on one class of meat, such as pork, a substantial increase may occur in purchases by panel members.

Frequently, some large meat wholesalers develop promotional programs in which several independent stores may feature the same meat items at the same time, with attractive in-store display materials tied in with newspaper advertisements.

Weekly average purchases of meats by panel members will probably by influenced by these merchandising activities. Part of the adjustment can be accounted for by changes in prices. However, the city-wide average prices used in this study can reflect only imperfectly the prices confronting individual consumers. Some individuals will purchase an item in one store at the advertised special price, while other families will have purchased in other stores where a more normal mark-up is being charged on the corresponding item.

It appears possible that sizable week-to-week fluctuations in meat purchases may be associated with corresponding adjustments in prices. However, shifts in demand may occur, depending on the extent of advertising and other promotional activities. There is no variable in the basic demand equation for meat groups to account for this type of demand shift. It would be very difficult to arrive at an empirical index representing the demand shifting effects of these merchandising practices, such as advertising. In this respect, the demand models are incomplete. Sizable residuals may occur for certain weeks and the multiple correlation coefficient may be reduced by the incompleteness of the model.

Lagged relationships. Little is known about the lagged relationships that may exist between meat purchases in one week compared with purchases during preceding weeks. Personal observation indicates that most consumers desire to provide variety in their meat diet. This variety can be obtained by purchasing different cuts of the same class of meat, different classes of meat, or by preparing the same retail cuts in a different manner. If a beef rib roast is served for Sunday dinner one week, it is highly probable that the family will prefer some other meat item the following Sunday. When working with the combined purchases of the panel members, most of this week-to-week shift in demand by individual families is likely to average out. However, in weeks following an extensive promotion and large purchases of a particular kind of meat, it would be expected that purchases the next week would be reduced as families purchasing the previous week shifted to other meat items.

Although separate analyses were made to obtain an indication of these lag relationships, no attempt was made to include lagged variables in the basic demand equations. This should be attempted in future research.

The results of a multiple regression analysis indicate that there is a significant relationship between the quantity of beef purchased by panel members in any given week and the quantity of certain other meat items purchased the previous week. The prediction equation computed was:

$$X_1 = .3804 + .2288\ X_2 + 1.2008\ X_3 + .1295\ X_4 + .4888\ X_5$$

where X_1 = the average quantity of beef purchased per family each week; X_2 = the average quantity of pork purchased per family in preceding week; X_3 = the average quantity of sausage purchased per family the preceding week; X_4 = the average quantity of poultry purchased per family the preceding week; and X_5 = the average quantity of fish purchased per family the preceding week. Weekly observations for the period July 1951 to December 1952 were used, omitting the major holiday weeks. The regression coefficient for X_2, pork, was significant at the 5 percent level while the coefficient for X_3, sausage, was significant at the 1 percent level. The coefficients for X_4 and X_5 were non-significant at the 5 percent level.

It is interesting to note that the coefficients are all positive, indicating that large purchases of a competing meat last week will be associated with increased purchases of beef this week.

This type of analysis suggests the nature of the lagged relationships between some of the different groups of meat. It is difficult to include variables in a single equation demand model that will account for this type of disturbance. One possibility would be to add the quantity of competing meats on a lagged basis as an additional explanatory variable. Since the price of the competing meat item is already one of the explanatory variables, a high intercorrelation with the quantity series would probably cause statistical difficulties.

The high degree of perishability of most meat items is largely responsible for the frequent purchase of these products. Lagged relationships due to week-to-week variations in consumer stocks of meats are probably much less important than for more durable food items. Families with ordinary home refrigerators are not likely to store fresh meats for more than a few days or a week. Cured and smoked items, such as ham, may be stored two or three weeks; for this reason greater week-to-week variation might be expected in the purchase of these items as consumers take advantage of special prices. As more and more families become users of home freezers or large freezer compartments in regular kitchen refrigerators, the problem of lagged relationships will become more important. In this study, large meat purchases for home freezers or locker storage were adjusted out of the data. (See page 72, Chapter IV.)

The Form of the Mathematical Function

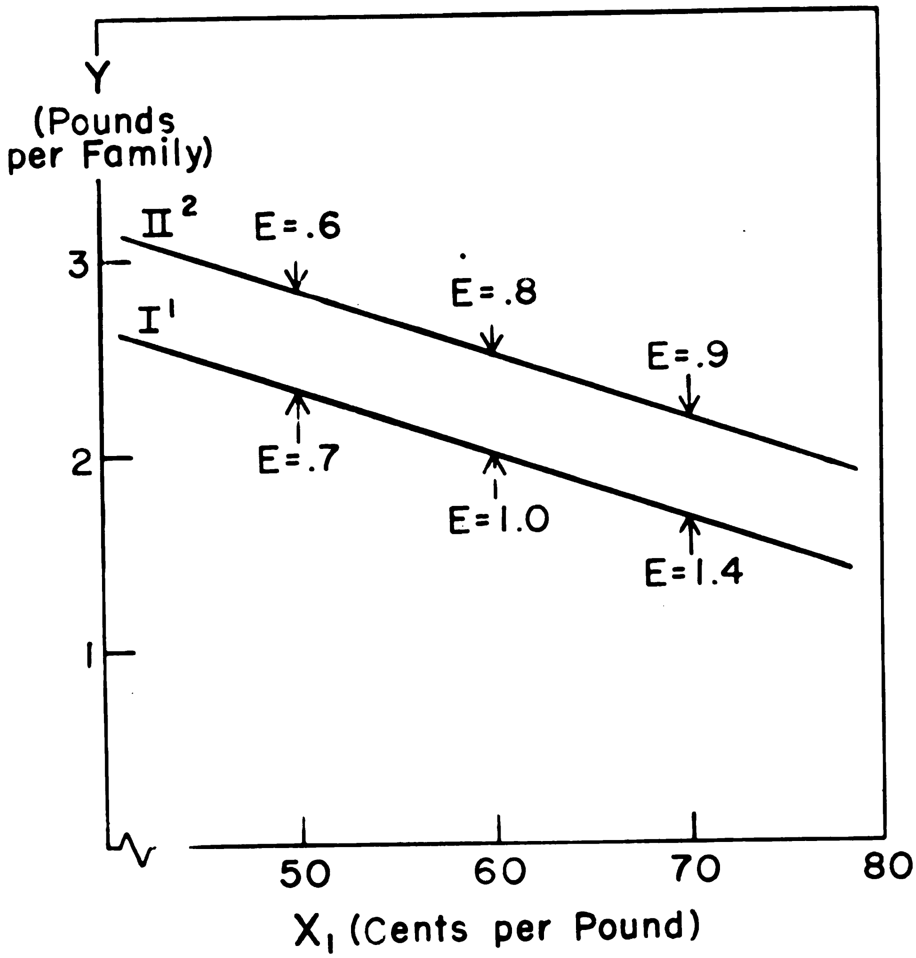
A linear relationship between the explanatory and the dependent variables was accepted as reasonable and practical. Scatter diagrams of the relationships between pairs of variables on arithmetic scales indicated no marked deviation from linearity. It was also reasoned that the ranges of variation in the price and quantity observations represented such a small segment of the total demand curve that the relationships obtained could reasonably be expressed by a linear function.

No strong preference for an arithmetic versus a logarithmic function could be arrived at by mere observation of scatter diagrams of price quantity observations. However, due to the large number of observations in each series of data and the number of variables in each equation, there were practical reasons for preferring the less laborious procedure of fitting a function that was linear in arithmetic terms. After experimenting with arithmetic relationships to determine the basic factors affecting meat purchases, it probably would be desirable to try some of the equations in logarithms in order to compare results.

The basic demand function used was of this type:

$$Y = a + b X_1 + c X_2$$

where the coefficients b and c, represent the amount by which Y changes for each one unit change in the explanatory variables X_1 and X_2. It is important to keep in mind that the elasticity, which is in percentage terms, varies for each point on the function represented by this type of equation. The demand



[1] $Y = 3.998 - .0333X_1$ [2] $Y = 4.498 - .0333X_1$

Figure XII. Variations in price elasticity along a demand function which is linear in arithmetic values and the effect of a parallel shift in the demand function.

function, I, shown in Figure XII, illustrates this situation. In this case the price elasticity at the mean values ($\bar{Y}$ = 2 pounds, $\bar{X}$ = 60 cents) is -1.0,[10] while at a price of 50 cents per pound the elasticity is -0.7 and at 70 cents it is -1.4. Assume a parallel shift in the demand function with the quantity increasing to 2½ pounds at 50 cents per pound. Here it can be seen that the price elasticity at the mean values has been reduced to -0.8. Both demand functions, I and II, have the same slope; therefore, the regression coefficients are identical. The constants, a, in the two equations are different, however.

The variation in elasticities, as shown in Figure XII, suggests that one should be careful in quoting elasticity measurements, particularly when an arithmetic function has been fitted. It is customary to give greater emphasis to the elasticity measured at the mean values of the variables involved.

The Basic Demand Equations

The dependent variables that were used in this series of single equation models were the average weekly purchases of five main groups of meat by all families in the M.S.C. Consumer Panel: They are as follows:

---

[10] Computed as follows: $b \frac{\bar{X}}{\bar{Y}}$ or $.0333 \frac{60}{2.5} = 1.0$

Y_1 = pounds of beef per family

Y_2 = pounds of pork per family

Y_3 = pounds of sausage per family

Y_4 = pounds of poultry per family

Y_5 = pounds of fish per family

The explanatory variables are the average weekly prices of these meat groups, total expenditures, total quantity, and a measure of income.

X_1 = price of beef

X_2 = price of pork

X_3 = price of sausage

X_4 = price of poultry

X_5 = price of fish

X_6 = average weekly income per family

(4 week or 13 week moving average)

CHAPTER VI

THE DEMAND FOR BEEF

Introduction

Beef is the most important meat item in the food budget of Lansing families. During the period July 1951 to June 1953, weekly expenditures for beef averaged $1.95 per family. this was 39 percent of the total meat bill, compared with 29 percent for pork, 13 percent for sausage, 12 percent for poultry, and 5 percent for fish (Table 15). During an average week approximately 81 percent of the panel families bought some kind of beef.

TABLE 15

AVERAGE WEEKLY PURCHASES OF MEAT
BY M.S.C. CONSUMER PANEL FAMILIES,
JULY 1951 to JUNE 1953*

Kind of Meat	Quantity per Family	Expenditure per Family	Expenditure as Percent of Meat Bill	Percent Buying
	pounds	dollars		
Beef	2.929	1.952	39.1	81.2
Pork	2.537	1.445	28.9	74.8
Veal	.119	..065	1.3	8.5
Lamb	.047	.030	.6	2.7
Sausage	1.115	.624	12.5	63.6
Poultry	1.243	.609	12.2	33.7
Fish	.511	.268	5.4	39.0
All meat	8.501	4.993	100.0	--

* Holiday weeks included.

The demand for beef at the retail level is actually a composite demand derived from the summation of individuals' demands for a wide variety of retail beef cuts. There are approximately 20 to 25 basic retail cuts that are obtained from a beef carcass. Wide variations exist in the cutting methods used in different retail outlets. Differences in the amount of bone and fat trimmed from the retail cuts also contribute to the non-homogeneity of cuts between stores. In addition to differences in cutting and trimming policies, there is a wide range in the quality of beef sold in different markets. In terms of U. S. Government grades, the "quality" of beef sold in retail stores in Lansing ranges from cow beef grading U. S. Utility to steer and heifer beef grading U. S. Prime. The bulk of the beef sold as fresh cuts will grade U. S. Commercial, U. S. Good, or U. S. Choice.[1] A large portion of the lower grades is merchandised in the form of ground beef and processed sausage items. Price spreads between grades of beef carcasses are usually large (Figure XIII). Among the different retail cuts, price spreads due to grade differences are greatest on the more desirable steaks, such as porterhouse, T-bone, and sirloin. Price spreads due

---

[1] North Central Livestock Marketing Research Committee, "Retailing Meats in the North Central States," preliminary draft of a bulletin manuscript summarizing data obtained in a survey of 1351 meat retailing outlets in the North Central States.

to grade differences are relatively small for the less desirable cuts, such as chuck roasts, stewing and boiling beef, and ground beef.

These wide differences in retail beef cuts complicate the analysis of the demand for beef. The impracticality of obtaining information on grades of beef from panel members was mentioned earlier. It was also impractical to obtain a detailed breakdown of individual cuts of beef. The following sub-groupings of retail beef cuts were used:

Canned beef
Corned or chipped beef
Ground beef, hamburger
Liver
Heart, tongue, other organ parts
Prepared baby food, beef
Roasts
Steak
Stewing, boiling, soup
All other beef

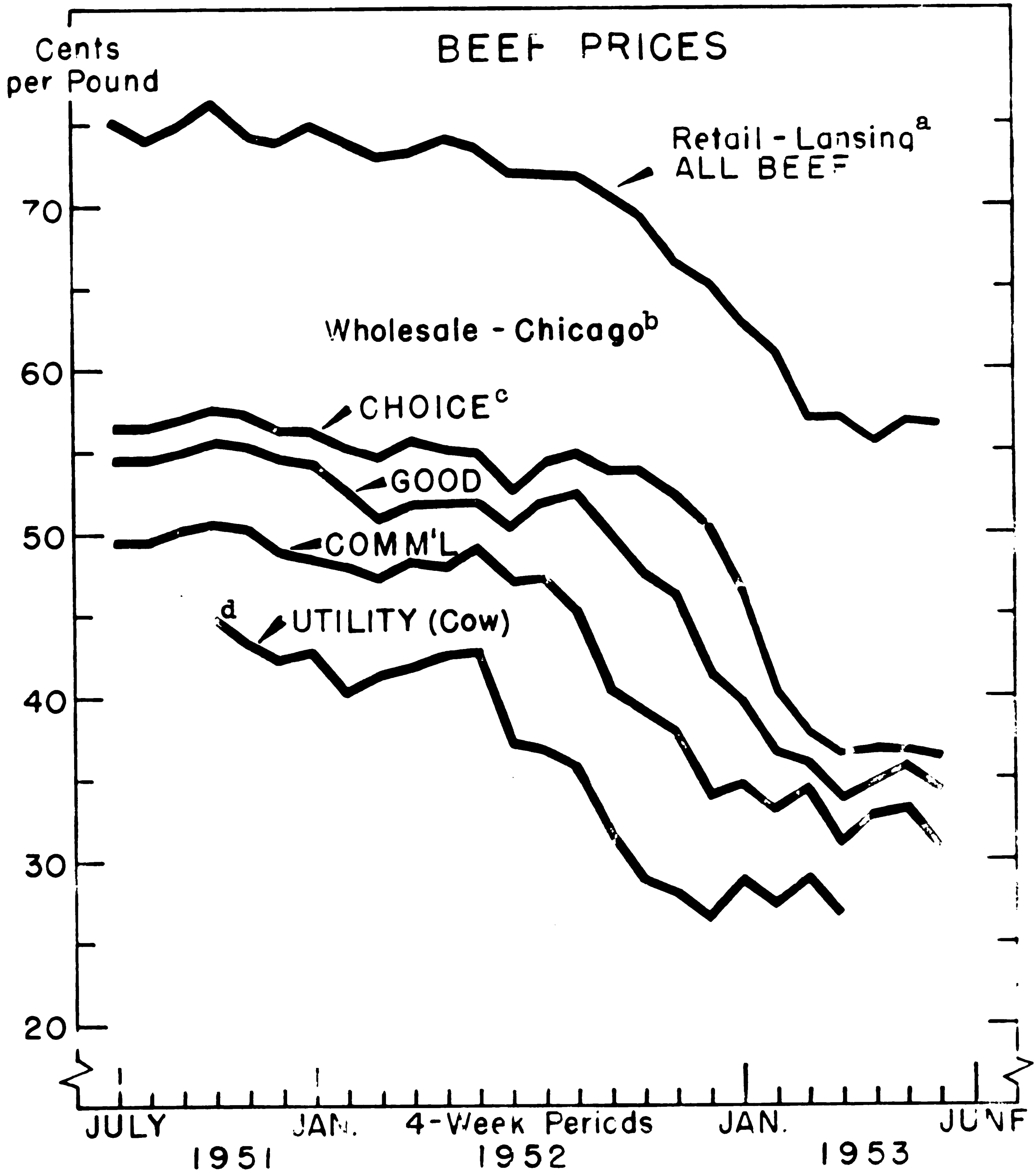
Although this classification permits a great deal of price variation within each sub-group, the M.S.C. Consumer Panel probably is one of the best sources of data that have become available to date to study demand for retail beef cuts.

The analysis of panel data on beef purchases has yielded some interesting results. The procedures used and the results obtained are described below. Attention was first centered on the demand for beef as a composite commodity. The basic demand equations formulated in the previous chapter were tested using least squares multiple regression techniques. This was followed by some preliminary analysis of the demand for retail cuts of beef.

Variations in Prices and Quantities

Substantial downward adjustments in beef prices occurred during the two-year period, July 1951-June 1953 (Figure XIII). This was the period for which data were available for this study. The average price of beef in Lansing ranged from 77 cents down to 55 cents per pound. Weekly average purchases by panel members varied from about two pounds per family to more than three and one-half pounds.

Beef prices were subject to controls by the Office of Price Stabilization from May 1951, until February 6, 1953. During the last half of 1951 and the first half of 1952, beef prices and the quantities purchased by panel members remained very stable. No widespread "shortages" of beef were reported; however, prices held near record high levels and the average per capita consumption of beef for the United States as a whole declined to the lowest levels since the latter part of World War II. National average annual beef consumption per person, on a wholesale carcass weight basis, was only 55



a M.S.C. Consumer Panel.

b Wholesale Dressed Meat Prices: Weekly Average of Daily Quotations, taken from weekly Market Reviews and Statistics, Livestock Br., P.M.A., U.S. Dept. of Agr.

c 500-600 pounds

d no quotations

Figure XIII. Comparison of retail beef prices in Lansing with wholesale prices for selected grades of beef at Chicago, four week averages, July 1951-June 1953.

pounds in 1951 (Table 16). This compares with 61 pounds per person in 1952 and an all-time record high of 77 pounds for 1953.

TABLE 16

MEAT CONSUMPTION PER PERSON BY QUARTER YEARS, U.S. AVERAGE, 1950 TO MID-1953[a]

Period	Beef	Pork[b]	Total Red Meats[c]
	pounds	pounds	pounds
1950			
January-March	15.5	18.2	36.6
April-June	15.4	16.3	34.7
July-September	16.0	14.8	33.9
October-December	15.6	18.8	37.2
Year	62.5	68.1	142.4
1951			
January-March	14.4	18.1	35.0
April-June	13.1	16.9	32.3
July-September	14.2	16.1	32.9
October-December	13.5	19.5	35.6
Year	55.2	70.6	135.8
1952			
January-March	14.3	19.6	36.0
April-June	14.5	16.9	33.9
July-September	16.2	16.0	35.2
October-December	16.2	19.5	38.9
Year	61.2	71.6	144.0
1953[d]			
January-March	17.5	17.9	38.4
April-June	18.9	14.9	37.1

a Agr.Mktg.Ser., U.S.Dept.of Agr. The Livestock and Meat Situation, Dec.-June, 1954, p.7.

b Pork excluding lard

c Includes beef, pork, veal and lamb, wholesale carcass weight equivalents.

d. Preliminary estimates for 1953.

Beef supplies began to expand by the second half of 1952 (Table 16). Supplies of the lower grades of beef became more plentiful, forcing wholesale prices downward by late summer of 1952. (Figure XXX). Prices of Choice steer beef, which was being handled in most of the large self-service meat departments, did not decline rapidly until early 1953.

The average price paid for beef by panel members began to decline during the last half of 1952, following the decline in wholesale prices for the lower grades of beef (Figure XIII). The quantities purchased responded promptly to the price reductions. The scatter diagram of price-quantity relationships (Figure XIV) suggests that consumers may have over-responded, considering the size of the price decline. This might have been brought about by the low level of consumption in the preceding year and a half, causing consumers to become "beef-hungry." It is also possible that beef prices were lower during the last half of 1951 and early 1952 than they would have been in the absence of control. If this were true, the response to price reductions in late 1952 may have been a return to more normal relationships between beef price and quantities purchased by panel members.

The big increase in beef supplies that occurred during the first half of 1953 was accompanied by sharp price reductions, particularly on the higher grades of beef (Figure XIII).

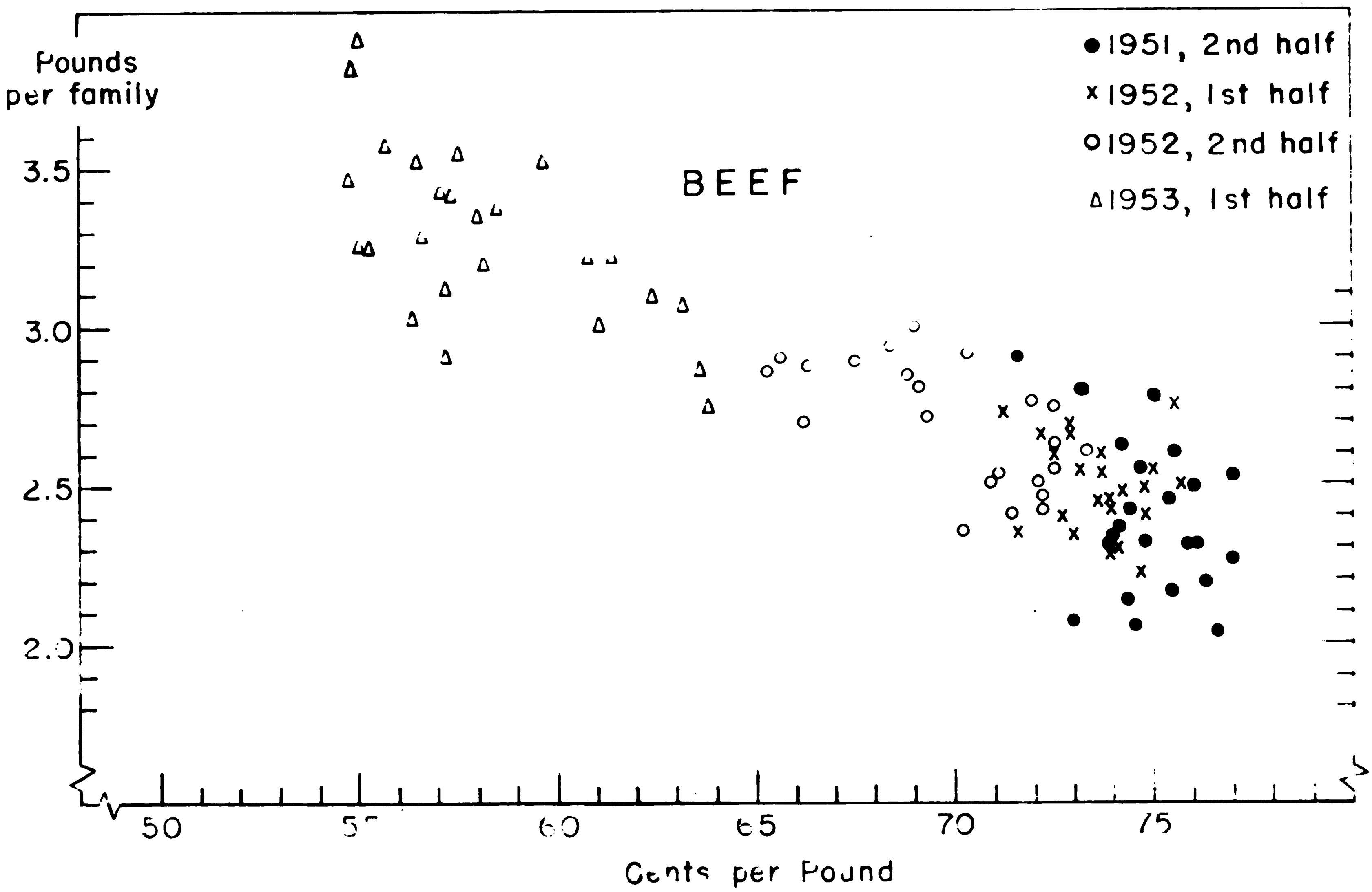


Figure XIV. Relationship between weekly average purchases and prices of beef, M.S.C. Consumer Panel, July 1951-June 1953, holidays omitted.

During this period most of the retail outlets were promoting the sale of beef. During the summer and fall of 1953, an industry-wide program was developed to stimulate beef sales. It is difficult to evaluate the results of such a program, but it is possible that demand for beef may have been increased by the special promotions that were carried on at this time.

In the scatter diagram shown in Figure XIV, there are two weeks during which beef purchases were extremely large. These occurred during the weeks ending March 21 and May 2, 1953. During these weeks beef prices dropped below 55 cents per pound and average purchases per family climbed to approximately four pounds. Extensive promotion of beef cuts at special prices apparently was responsible for these large purchases.

The pattern of beef purchases may have been affected by the supplies and prices of competing meats. The influence of these factors was taken into consideration in a regression analysis. During most of the two-year period for which panel data are available, large supplies of pork were available (Table 16). During the spring and early summer of 1953, pork production began to contract, as a cyclical reduction in hog numbers began to be reflected in market supplies. This downward adjustment in pork supplies happened to coincide with the rise in beef supplies. Nevertheless, total supplies of red meats were increasing from mid-1952 until mid-1953 (Table 16).

Results of Regression Analyses

July 1951 to December 1952. The first equation to be fitted mathematically was of the type described in Chapter V, page 116. The weekly average purchases of beef were expressed as a linear function of the price of beef, the prices of competing meats, and family income. Observations for the weeks in which the major holidays (Thanksgiving, Christmas, and Easter) occurred were omitted. A four-week moving average was used as the measure of current income of panel families.

The simple correlation between the quantity of beef and the price was 0.61 (Table 17). The simple correlations between the quantity of beef and the price of competing meats were all relatively small, ranging from -.15 for the price of poultry to .33 for sausage. A relatively high correlation was observed between quantity of beef and income, and there was a high intercorrelation with the price of beef. With the exception of a correlation of .52 between the price of beef and the price of sausage, the correlations between pairs of prices were relatively small.

TABLE 17

SIMPLE CORRELATIONS BETWEEN PAIRS OF VARIABLES, BEEF EQUATION, JULY 1951 TO DECEMBER 1952

Variables	Variables					
	X_1	X_2	X_3	X_4	X_5	X_6
Q of beef, Y_1	-.608	-.172	-.326	-.153	.317	.519
P of beef, X_1		.042	.521	.108	-.312	-.599
P of pork, X_2			.331	.079	.280	-.371
P of sausage, X_3				.005	-.129	-.402
P of poultry, X_4					-.001	-.295
P of fish, X_5						-.018
Income, X_6						

Fitting the equation by least squares procedures produced a multiple correlation coefficient of .71 with a standard error of estimate of .16 pounds and a mean of 2.54 pounds. The prediction equation was (1.1) $Y_1 = 3.9547 - .0388X_1 - .0096X_2 + .0077X_3 - .0024X_4 + .0140X_5 + .0094X_6$. The regression coefficient for X_2, price of pork, was negative and non-significant. *A priori* reasoning suggests that pork is competitive with beef; therefore, the sign of the coefficient would be expected to be positive. The coefficient for X_4, the price of poultry, was also negative; however, no strong relationship was expected between the price of poultry meat and beef purchases.

The beta coefficients and their standard deviations were computed and t values were obtained on each of the coefficients. The results are summarized in Table 18. The tests of significance indicate that only the price of beef had a strong influence on the quantity of beef purchased. It was rather suprising to find the price of fish having a significant effect on beef purchases, while non-significant influences were registered for the prices of pork, poultry, and sausage meats.

The price elasticity of demand computed at the mean price and quantity was -1.11. This indicated that a 1 percent change in the price of beef was associated with a change in the opposite direction of 1.11 percent in quantity of beef purchased by families in the M.S.C. Consumer Panel during the period studied. Stated in absolute terms, the regression coefficient indicated that a change of 5 cents per pound in the price of beef was associated with a change in the opposite direction of .19 pounds in weekly average purchases of beef by Lansing families.

The residuals were computed for the demand equation described above (Figure XV). As might be expected from an equation having a R of .71, there are quite large residuals for some weeks. This suggests several possible problems. One is

that additional explanatory variables are needed to account for the week-to-week changes in beef purchases. These variables might include some measurements of advertising activity and certain lagged relationships in purchases.

TABLE 18

SUMMARY OF REGRESSION RESULTS, BEEF EQUATION (1.1)
JULY 1951-DECEMBER 1952

Statistical Measure	Variables					
	Price of Beef	Price of Pork	Price of Sausage	Price of Poultry	Price of Fish	Income
	X_1	X_2	X_3	X_4	X_5	X_6
Beta's	-.4864	-.1565	.0697	-.0261	.2436	.2353
σ_β	.1316	.1054	.1099	.0917	.0976	.1270
t value*	3.70	1.49	.63	.03	2.50	1.85
Means	72.8	59.2	60.8	50.9	61.3	82.43

* With 65d.f., $t_{.05} = 1.997$, $t_{.01} = 2.654$. Based on table of t values in George W. Snedecor's, Statistical Methods, Iowa State College Press, Ames, Iowa, 4th ed., 1946, p.65.

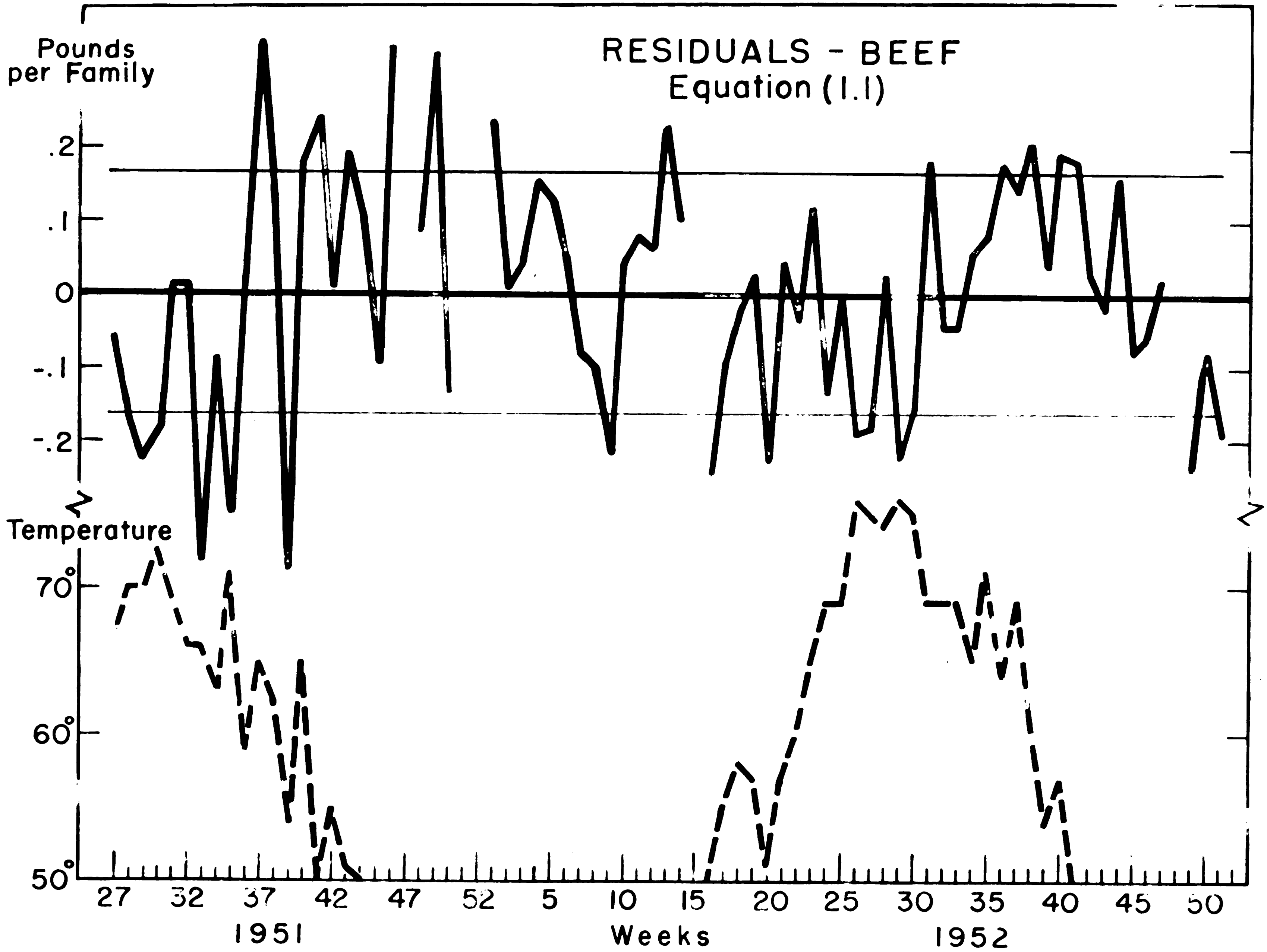


Figure XV. Residuals from beef equation (1.1) compared to the weekly average of mean daily dummer temperatures in Lansing.

Perhaps one of the more striking characteristics of the residuals in Figure XV is the seasonal pattern. This is not surprising since it was expected that there were some seasonal shifts in demand for beef. The residual pattern shows that beef purchases were low relative to price during the summer months and high during the fall and winter. This suggests that a demand shifter, closely related to these seasons, would explain some of the variability in the data. Temperature has been used by others as such as a demand shifter.[2]

When dealing with the meats, it is doubtful that temperatures below a certain critical level have much effect on demand. Weekly averages of mean daily temperatures in Lansing were plotted with the residuals in Figure XV. It appeared that some relationship existed, but it was difficult to determine the critical level of temperature below which demand was not affected. In moving from summer to fall, it appears that somewhere around 60 to 65 degrees was the level at which demand increased as temperatures declined. Above 65 degrees, weekly purchases of beef seem to be inversely correlated with sharp temperature increases. This same temperature level seems

---

[2] G. G. Quackenbush and J. D. Shaffer, "Consumer Purchases of Ice Cream for Home Use," Unpublished manuscript, Dept., of Agr. Econ., Michigan State College. See also: George M. Kuznets and R. L. Klein, A Statistical Analysis of the Domestic Demand for Lemons, 1921-41, Giannini Found., Agr. Econ. Rept. 84, 1943.

to be closely related with the decline in demand which began in May 1952. Part of the negative residuals immediately following Easter are probably due to the lag effects of ham purchases for the holiday.

A significant correlation was found to exist between temperature and the beef residuals (Equation 1.1) for the warm season of the year. The period considered as part of the warm season included all of the weeks occurring in 1951 between July 1 and October 20, and in 1952 between April 27 and October 18. The temperature variable was constructed by subtracting 60 degrees from the weekly averages of mean daily temperatures in Lansing. All weekly averages of 60 degrees or less were assigned a value of zero based on an assumption that below this level temperature becomes unimportant as a demand shifter. The correlation between temperature and the beef residuals was -.38 with 41 weekly observations. A least squares regression of beef residuals on temperature, using the same data, produced a regression coefficient of -.0122. This indicates that a 10 degree increase in weekly average temperatures would decrease the quantity of beef purchased by the average Lansing family by .12 pounds. This is equivalent to about a 5 percent decline from the average of weekly purchases for the July 1951-December 1952 period.

Similar correlations and regressions were computed using all the weeks in the July 1951-December 1952 period.[3] Here again all weekly average temperatures of 60 degrees or less were given a value of zero. The correlation between the temperature variable and beef residuals was -.31 and the regression coefficient was -.0101. This coefficient was significant with a t ratio of 2.73. These results were reasonably consistent with the statistical results obtained for the warm season period.

<u>July 1952 to June 1953</u>. As data became available a new series of analyses were made using observations for the period during which sizable changes occurred in the prices and purchases of beef. Data for the period July 1951 to June 1952 were not included since there is some question about the disturbance of normal relationships caused by price controls. A 13-week moving average of family income was used in place of the 4-week moving average used in the previous analysis. The principal reason for making this substitution was to eliminate the variability in the income series due to the non-uniform pattern of pay periods among families in the panel.

A simple correlation of -.87 (Table 19) between the quantity and price of beef was obtained from this analysis as compared to the -.61 for the earlier period when only small changes were observed in prices. The correlations between income,

---

[3] Major holiday weeks were omitted.

beef prices, and quantities were also substantially increased. The high correlation of -.95 between beef prices and income indicates that the multiple regression results may be unduly biased by the intercorrelation among the explanatory variables.[4] An intercorrelation of .546 is also noted between the price of sausage and the price of beef. This relationship is not surprising considering the fact that beef is one of the major components of sausage. There was also an intercorrelation of 0.65 between the price of sausage and income. The high correlation between the income variable, the price of beef, and the price of sausage was believed to be partly a chance relationship. Although the rise in income probably had some influence on demand for beef and other meats, the steady increase in beef supplies and the constant downward pressure on beef prices are closely associated with the rise in incomes which began in the fall of 1952 and extended through the first half of 1953. When data are available over a longer period of time, during which beef supplies turn downward, the correlation between income and beef prices would be expected to decline substantially.

---

[4] Karl A. Fox and James F. Cooney, Jr., Effects of Intercorrelation upon Multiple Correlation and Regression. Agr. Mkt. Ser., U.S.Dept.of Agr., Processed Report, 1954. 28 pp.

TABLE 19

SIMPLE CORRELATIONS BETWEEN PAIRS OF VARIABLES, BEEF EQUATION, JULY 1952-JUNE 1953.

Variables	Variables					
	X_1	X_2	X_3	X_4	X_5	X_6
Q of beef, Y_1	-.874	.098	-.509	.333	.225	.813
P of beef, X_1		-.116	.546	-.486	-.216	-.952
P of pork, X_2			.392	.050	.257	-.021
P of sausage, X_3				-.234	-.236	-.649
P of poultry, X_4					.189	.480
P of fish, X_5						.216
Income, X_6						

Three multiple regression equations were fitted to the data for the period July 1952 to June 1953. The first, (1.2), was the basic demand equation similar in structure to equation (1.1). The second equation, (1.3), was the same as (1.2), but the income variable was omitted in an attempt to avoid part of the intercorrelation problem mentioned above. Equation (1.4) involved a substitution of the quantity of fish purchased in place of the price of fish as the X_5 variable. Equation (1.5) is the same as (1.3) except that temperature was added as X_7. The prediction equations multiple correlation coefficients, and the standard errors of estimates are shown on the following page.

$$(1.2)\,Y_1 = 11.2818 - .0706X_1 - .0015X_2 - .0163X_3 - .0181X_4 + .0043X_5 - .0232X_6$$

R = .886

Sy.x - .1733

$$(1.3)\,Y_1 = 7.5735 - .0531X_1 + .0008X_2 - .0084X_3 - .0189X_4 + .0040X_5$$

R = .882

Sy.x = .1763

$$(1.4)\,Y_1 = 8.8416 - .0562X_1 - .0018X_2 - .0117X_3 - .0244X_4 + .4221X_5$$

R = .886

Sy.x = .1738

$$(1.5)\,Y_1 = 5.2183 - .0444X_1 + .0142X_2 + .0018X_3 - .0079X_4 + .0012X_5 - .0235X_7$$

R = .909

Sy.x = .1559

Although the variations in these equations had almost no effect on the multiple correlation coefficient, there is a striking difference between the regression coefficients for X_1, the price of beef. When the income variable was included in the equation, a regression coefficient of .0706 was obtained

TABLE 20

SUMMARY OF REGRESSION RESULTS, BEEF EQUATION
JULY 1952 - JUNE 1953

Statistical Measure	Price of Beef X_1	Price of Pork X_2	Price of Sausage X_3	Price of Poultry X_4	Price of Fish X_5	Family Income X_6
Equation (1.2)						
Beta's	-1.1943	-.0161	-.0935	-.1205	.0447	-.3369
σ_β	.2608	.0941	.1131	.0814	.0796	.2744
t-values	4.58	.17	.83	1.48	.56	1.23
Equation (1.3)						
Beta's	-.8991	.0084	-.0481	-.1264	.0411	
σ_β	.1029	.0936	.1088	.0827	.0809	
t-values	8.74	.09	.44	1.53	.51	
Equation (1.4)						
Beta's	-.9515	-.0197	-.0670	-.1631	-.1103[a]	
σ_β	.1112	.0953	.1010	.0875	.0882	
t-values	8.56	.21	.66	1.86	1.24	
Equation (1.5)						
Beta's	-.7516	.1639	.0105	-.0526	.0123	-.3207[b]
σ_β	.1016	.0953	.0988	.0770	.0729	.0937
t-values	7.39	1.72	.106	.683	.176	3.42

a Quantity of fish substituted as X_5 in place of price of fish.

b Temperature variable, noted as X_7 in Equation (1.5), page 139.

for X_1, as compared to .0531 when income was omitted. The corresponding elasticities at the mean values of price (63.9 cents) and quantity (3.01 pounds) were -1.50 and -1.13. Dropping the income variable had relatively little effect on the other regression coefficients. The coefficient for pork, X2, changed from negative to positive, but neither coefficient was significant (Table 20).

Substituting quantity for the price of fish, as X_5 in the equation, yielded a slight change in the importance of fish as a factor influencing beef purchases (Table 20). The increase in fish purchases, during the Lenten period, was quite apparent in the quantity series but was hardly discernable in the price series. Consequently, the shift in demand from red meats and towards fish was probably better represented by the quantity series on fish than by the price series. This, plus the fact that the average price of fish is relatively unstable, were the principal reasons that could be offered for the shift in relationships. Although the t value for the quantity of fish was much larger than for price of fish, it was still not large enough to be significant at the 5 percent level.

Adding temperature as a variable in equation (1.5) produced some interesting results. The coefficient for X_1, the price of beef, declined to -.0444. The price elasticity based on this coefficient was -.94 at the mean values of price and quantity. The coefficient for X_2, the price of pork, became significant at the 10 percent level. The cross elasticity with the price of pork was .31 measured at the means. The coefficients for the prices of sausage, poultry, and fish again were non-significant; however, the temperature variable was highly significant. The temperature coefficient indicated that an increase of 10 degrees in mean temperature was associated with a decrease of .235 pounds (about 8 percent) in beef purchases per family.

The residuals for equation (1.5) were computed and plotted graphically. No significant seasonal variation was discernible. This indicated that the temperature variable, used as a "demand shifter," had accounted for most of the shift in demand between the warm and cool seasons.

A question arose with regard to the possible autocorrelation of the residuals for the above equations. It was pointed out earlier that one of the underlying assumptions of ordinary least squares regression is that the residual errors are independent of one another. The residuals for equation (1.3) were tested using the ratio of the mean square successive differences to the variance.[5] The ratio, $\frac{\delta^2}{s^2}$, was equal to 1.97, which was non-significant according to the distribution table

---

5 There is some disagreement over the validity of this test, however, some of the other tests are also questionable. See Lawrence R. Klein, Econometrics, Row, Peterson and Co., Evanston, Ill.,1953, p.89. See also: R.L.Anderson, "The Problems of Autocorrelation in Regression Analysis," Jour.Amer.Stat.Assoc.,, Vol.49,1954, p.117.

tabulated by Hart and von Neumann.[6] This test was followed by a simple correlation of the residuals where X_1 = residuals for time period t and X_2 = the residuals for time period t - 1. The correlation coefficient was .056, which was very low and non-significant. A tentative conclusion was that autocorrelation of residuals was not a serious problem; however, further analysis using other methods of testing may be desirable.

In cases where a high degree of autocorrelation existed there have been attempts to minimize the difficulty by converting the raw data into first-differences.[7] An attempt to use first-differences on beef purchase data yielded a rather low multiple correlation coefficient. An R of .33 was obtained when the quantity of beef was taken as a linear function of the price of beef and the price of pork. Weekly observations for the July 1952-June 1953 period were used. Holiday weeks were omitted. The simple correlation between the quantity and price, in first-differences, was -.23. The regression coefficient for the price of beef was -.0408 with a T value of 1.84. The regression coefficient for the price of pork

---

[6] B. I. Hart, "Significance Levels for the Ratio of the Mean Square Successive Difference to the Variance," Annals of Math. Stat., Vol.13, 1942, pp.445-47.

[7] D. Cochrane and G.H.Orcutt, "Application of Least Squares Regression to Relationships Containing Auto-Correlated Error Terms," Jour.Amer.Stat.Assoc., 44:32-61, 1949.

was .0249 with a t value of 1.68. (With 49 observations a t value of 2.0 is significant at the 5 percent level.) Based on this first difference analysis, the price elasticity of demand for beef was -.75 at the mean quantity and price. The cross elasticity with the price of pork was .21.

Summary

Which of the regression equations produced the "best" estimates of the structural relationships among the studied variables? An answer to this question must be based partly on subjective considerations. The results of the first equation (1.1) were subject to criticism because the period July 1951 to December 1952, included the period during which beef prices were subject to government control. Equation (1.2) appeared to be unduly disturbed by the high intercorrelations existing among the variables incomes, the price of beef, and the quantity of beef. The results of equations (1.3) and (1.4) appear to be superior to either of the first two equations. In some respects equation (1.5) may have yielded even better results than (1.3) or (1.4). In (1.5) an attempt was made to provide a variable to act as a "demand shifter" between the warm and cool seasons of the year. The multiple correlation coefficient was increased to .909 and the relationship between the price of pork and beef purchases seemed more reasonable than the results indicated in the previous equations. The regression coefficient for the price of beef was lower in equation (1.5) than in any other equation except (1.1), but appeared to be reasonable. The lower estimate indicates that a decline of 5 cents per pound in the weekly average price of beef was associated with an increase of .22 pounds in average beef purchases per family. The higher estimate indicates an increase in purchases of .28 pounds per family with each 5 cent decline in price. The coefficient for the price of pork, in equation (1.5), indicates that a 5 cent rise in the price of pork was associated with an increase of .07 pounds in beef purchases.

The Demand for Selected Retail Cuts

From the ten sub-groups of retail beef cuts listed in the panel diary, three were selected for special study. These are ground beef, roasts, and steaks. During the period July 1952 to June 1953, these three items made up 88 percent of the total quantity of beef purchased at retail.

Ground beef was the largest item with weekly average purchases of 1.09 pounds per family. This compares with .88 pounds for roasts and .63 pounds for steak (Table 21). Ground beef is by far the largest traffic item with about 60 percent of the families buying each week. Steaks attracted about 35 percent of the families each week while 25 percent purchased roasts. These percentages and relative quantities vary with prices as will be pointed out below.

TABLE 21

RELATIVE IMPORTANCE OF SELECTED RETAIL CUTS OF BEEF
M.S.C. CONSUMER PANEL, JULY 1952-JUNE 1953*

Retail Cuts	Pounds per Family	Percent Buying	Expenditure per Family	Price per Pound
			dollars	cents
Ground beef	1.09	59	0.58	53.6
Roasts	.88	26	0.57	64.9
Steaks	.68	37	0.56	82.1
Stewing and boiling	.13	7	0.06	46.6
All others	.23	--	0.15	65.2
Total beef	3.01	--	1.92	63.9

* Holiday weeks, Thanksgivings, Christmas and Easter omitted in computing averages

Consumer responses to declining beef prices were somewhat different for the three sub-groups of retail beef cuts. The nature of these differences are revealed in Table 22. In order to avoid disturbances due to seasonal variations in demand, purchase data for the 2d quarter of 1952 were compared to corresponding data for the 2d quarter of 1953. During this period of time, beef prices declined more than 20 percent. The price of ground beef fell from 66 to 45

cents per pound. Consumers responded by increasing average weekly purchases from .96 pounds per family to 1.12 pounds. This response was insufficient to prevent expenditures from declining from 64 cents per family per week to 51 cents. This indicates that the "price elasticity of demand" for ground beef was inelastic within this range of observations. It is also interesting to note that the percent of families buying ground beef in any given week was practically unchanged between the two periods.

Between these same periods the average price of beef roasts declined about 18 cents from 73 cents per pound to 55 cents. Consumers responded by increasing their purchases from .75 pounds to 1.02 pounds per family per week. Part of this increase in purchases was due to a greater proportion of the families buying each week. Expenditures per family for roasts increased from 54 to 56 cents per week, indicating that the price elasticity of demand was slightly elastic.

The greatest response to price changes occurred on steaks, which was not particularly surprising. The average price of steak declined about 17 cents, from 91 cents per pound to 74 cents. Purchases nearly doubled in response to the price decline. The percent of families buying steaks in any given week rose from 29 to 42 percent. Weekly expenditures for steak increased from 42 cents per family to 62 cents indicating a highly elastic demand.

TABLE 22

COMPARISON OF PURCHASES OF SELECTED RETAIL CUTS OF BEEF M. S. C. CONSUMER PANEL 2d QUARTER OF 1952 and 2d QUARTER OF 1953

Retail Cut and Period	Weekly Average			
	Price per Pound	Pounds per Family	Percent Buying	Expenditure per Family
	cents			cents
Ground beef:				
2d quarter 1952	66.4	.96	58.3	63.7
2d quarter 1953	45.4	1.12	58.0	50.9
Roasts:				
2d quarter 1952	72.5	.75	22.9	54.4
2d quarter 1953	54.7	1.03	29.8	56.3
Steaks:				
2d quarter 1952	90.9	.46	28.5	41.8
2d quarter 1953	74.0	.84	41.7	62.2
Total 3 cuts				
2d quarter 1952	73.7	2.17	--	159.9
2d quarter 1953	56.6	2.99	--	169.4

It was interesting to observe the shifts which occurred in relative quantities purchased of these three major subgroups of beef cuts (Table 23). In percentage terms there was a sizable shift from ground beef to steaks, which poses an interesting question with regard to the relative proportions of the different retail cuts.

Individual beef carcasses of the same grade and weight, broken into retail cuts by the same cutting procedure, will normally yield nearly fixed proportions of the different cuts. Therefore, the variation in the relative proportions of hamburger and steak sold in Lansing in 1952, as compared to 1953, might be due to two factors: (1) a change in the composition of wholesale beef cuts shipped into the Lansing market; (2) changes in cutting procedures in the retail stores so as to merchandise a higher proportion of the beef as steaks.

It is entirely possible that the composition of wholesale beef supplies received in Lansing retail outlets did change between the second quarter of 1952 and the second quarter of 1953.

During the late spring and summer of 1953 an unusually large percentage of the total beef supply for the U.S. graded

TABLE 23

CHANGES IN THE RELATIVE QUANTITIES AND EXPENDITURES FOR GROUND BEEF, ROASTS AND STEAKS, M.S.C.CONSUMER PANEL, 2d QUARTER OF 1952 COMPARED TO THE 2d QUARTER OF 1953

Retail Cut	Quantities		Expenditures	
	1952	1953	1952	1953
	pct.	pct.	pct.	pct.
Ground beef	44	37	40	30
Roasts	35	34	34	33
Steaks	21	28	26	37
Total	100	100	100	100

in the choice and prime grades.[8] This was the result of record numbers of cattle being placed in feed lots the previous fall. As these large supplies of the better grades of cattle moved into trade channels, the spread in prices became extremely narrow (Figure XIII). It is likely that a larger proportion of choice beef was sold in the retail stores of Lansing as a result of the overall adjustment in supplies

[8] According to statistics from market reports issued by the Livestock Division of the Agricultural Marketing Service, U.S.Dept.,of Agriculture, 71 percent of the beef steers sold out of the first hands for slaughter at Omaha, Chicago, and Sioux City, during the second quarter 1953, were choice and prime. This compares with 62 percent for the second quarter of 1952.

and prices. It is also reasonable to expect that a relatively larger proportion of a choice carcass can be merchandised as steaks as compared to lower grades of beef carcasses.

Another explanation of the shift toward more steak and less ground beef is that a larger proportion of the wholesale cuts shipped into the Lansing area in 1953 may have been hindquarters as compared to 1952. The hindquarter of beef is the source of most of the steaks in the carcass. With the sharp decline in beef prices and a general broadening of the market for beef cuts, an increasing proportion of the front quarters of beef may have been channeled to lower income areas of the country. These lower priced cuts probably could be merchandised to a greater advantage there than in the Lansing market where the average level of incomes is relatively high.

It is difficult to estimate the extent to which retailers were able to change their cutting procedures so as to increase the proportion of steaks in relation to ground beef. However, the use of steak machines to tenderize cuts makes it possible to move a larger proportion of a beef carcass as steaks rather than roasts or ground beef.

Regression analyses of price-quantity relationships for the three groups of retail beef cuts further substantiated some of the general conclusions indicated in Table 22. This analysis was limited to simple two-variable correlations and regressions, treating each group of retail cuts separately.

Weekly observations for the period July 1, 1952 to June 1953 were used with major holiday weeks omitted.

The results of these computations are briefly summarized in Figure XVI. Here it can be seen that family purchases of ground beef increased an average of only .0031 pounds for each one cent decline in the price. The low correlation of -.32 between prices and quantities indicated that the relationship was rather weak. Purchases of roasts tended to increase about .0174 pounds for each one cent decline in average price. The correlation between prices and quantities was -.76 which indicated a fairly strong relationship. The response of consumers to price reductions on steak was the greatest among the three groups of cuts studied. Family purchases tended to increase by .0207 pounds for each one cent decline in steak prices. A high correlation of -.90 was observed between prices and quantities.

The preliminary analysis of data for retail beef cuts offers at least tentative evidence that there are significant differences in the demand characteristics among the various cuts.

Ground beef apparently is a staple meat item in the food budgets of most families. The small increase in purchases associated with rather large price declines, can be rationalized in terms of both an income and substitution effect. For

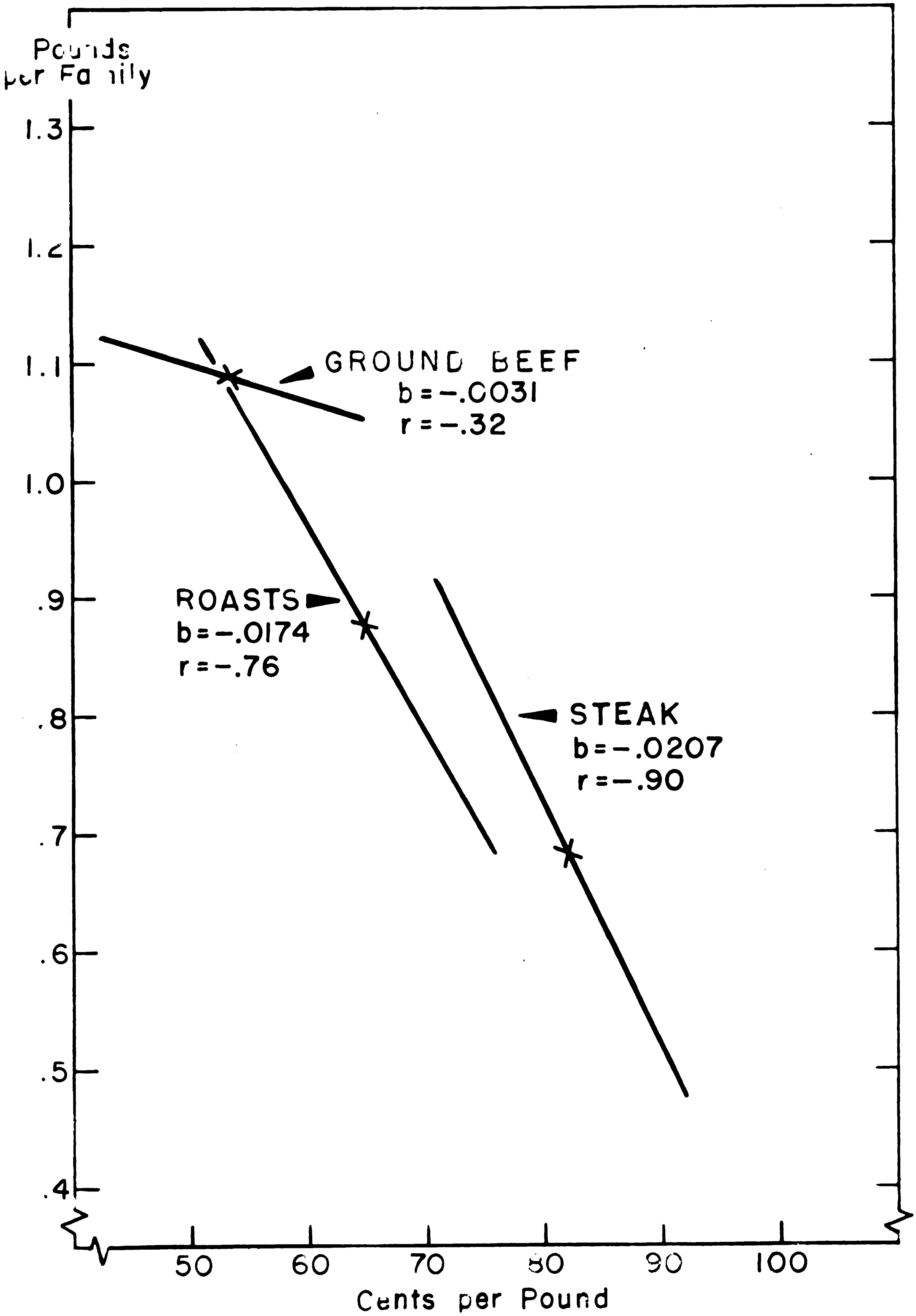


Figure XVI. Relationships between weekly average purchases and prices for selected retail cuts of beef, July 1952-June 1953, holidays omitted.

many families ground beef is an inferior good.[9] As prices declined for ground beef and all other beef cuts the substitution effect tended to increase quantities purchased. The income effect may have been acting to reduce purchases of ground beef with the net result being a small increase in total sales. More detailed analysis will be required to determine the proportions of the families for which ground beef is an inferior good.

Beef steak appears to be a highly superior item in the typical family food budget. The income and substitution effects of price declines both tend to increase purchases. Although the same general demand characteristics are observed for beef roasts, the income and substitution effects are less pronounced than they are for steaks. This is due in part to the influence of some of the less desirable pot roasts which may be inferior goods for a sizable proportion of the families in the panel.

The above relationships are gross relationships where no attempt has been made to allow for the effect of changing prices of competing meat cuts. Further analysis will be required to obtain estimates of the structural relationships between the different retail cuts.

---

[9] See Figure II, page 17 and Table 5, page 51.

CHAPTER VII

THE DEMAND FOR PORK

Introduction

Pork is slightly less important than beef in the food budgets of families participating in the M.S.C. Consumer Panel. During a two year period beginning July 1, 1951, average weekly expenditures for pork were $1.44. This compared with $1.95 spent for beef. Pork expenditures made up 29 percent of total expenditures for all meats as compared to 39 percent for beef. The differences in importance between beef and pork are less in terms of quantities. In fact, during the last half of 1951 and the first half of 1952, more pounds of pork were purchased than beef. In any given week about 75 percent of the panel families purchase some kind of pork.

The demand for pork is an aggregation of the individual demands for a wide variety of retail cuts. These cuts range in value from neck bones at 10 cents per pound to Canadian bacon and center cut ham slices selling for $1.25 to $1.50 per pound.

Families in the M.S.C. Consumer Panel report their pork purchases under 14 different categories. These are listed in Table 24 along with average expenditures and prices for the

TABLE 24

RELATIVE IMPORTANCE OF DIFFERENT RETAIL PORK CUTS PURCHASED BY FAMILIES IN M.S.C. CONSUMER PANEL, JULY 1952 - JUNE 1953*

Retail Cut	Weekly Purchase Data			
	Quantity per Family	Expenditure per Family	Average Price per Pound	Percent of Families Buying
	pounds	dollars	cents	
Fresh				
Chops	.332	0.25	75	26
Roasts	.259	0.14	57	8
Steaks	.097	0.06	63	6
Sausage	.196	0.11	55	17
Spareribs	.075	0.04	50	3
Other pork	.047	0.02	48	3
Cured				
Ham	.432	0.30	71	18
Picnics, shoulder butts	.131	0.09	43	4
Bacon	.452	0.25	56	36
Canadian bacon	.018	0.02	127	3
Salt pork	.040	0.02	44	4
Canned pork	.008	0.01	52	1
Offal				
Liver	.040	0.01	35	4
Heart, tongue or other organ parts	.010	0.01	34	1

* Holiday weeks omitted

year beginning July 1, 1952. The most popular cuts are bacon, ham, chops, roasts, and sausage.

There is more uniformity in retail pork cuts among the retail stores than there is in beef cuts. This is partly because the overall pork supply is much more uniform in quality than is beef. Another factor contributing to uniformity is that more of the cutting and processing of pork is performed at the packing plant as compared to beef. Rarely does a retailer buy a side of fresh pork. It is much more common to buy loins, hams, picnics, and prepackaged bacon. Some of these cuts require little or no processing in the retail store.

Even though pork cuts are more uniform between stores than is beef, there are significant price differences within stores for different brands of pork products. Most packers ordinarily merchandise at least two brands of bacon. One brand is a premium brand while the other is a brand to meet low priced competition. Hams and picnics are also merchandised by brand names. There are also price differentials between stores and within stores for pork cuts from hogs of different weights. Ordinarily, retail cuts from "heavy" hogs sell at a discount. Price variations are also related to the amount of boning and trimming of fat done by retailers and processors.

Weekly purchases of cured pork products seem to fluctuate more than purchases of fresh pork. This is probably related to the greater storability of the cured items which will keep for two to three weeks under refrigeration while fresh pork keeps for only a few days. Variations in consumer stocks of cured pork are probably related to the timing of promotional programs by the retail stores on items like hams and picnics. When featured as specials, the bulk of the sales will be in large units such as half or whole hams and whole picnics. These items are not likely to be completely consumed within a week by the average family. Consequently, purchases of cured pork are inclined to fluctuate more widely from week to week than are purchases of beef and fresh pork.

Variations in Prices and Quantities

Retail pork prices have moved within a relatively wide range during the two year period covered by this study. The highest weekly average price in Lansing was 72 cents per pound recorded in June 1953. The low was 50 cents per pound which occurred in January 1952.

During most of this two year period (July 1951 to June 1953) pork consumption was at a very high level. Average annual consumption for the United States was 71 pounds in 1951 and 72 pounds in 1952. Consumption has been larger than this in only four out of the past 20 years, and two of these years occurred during World War II when hog production reached its all-time record high. The current hog production cycle

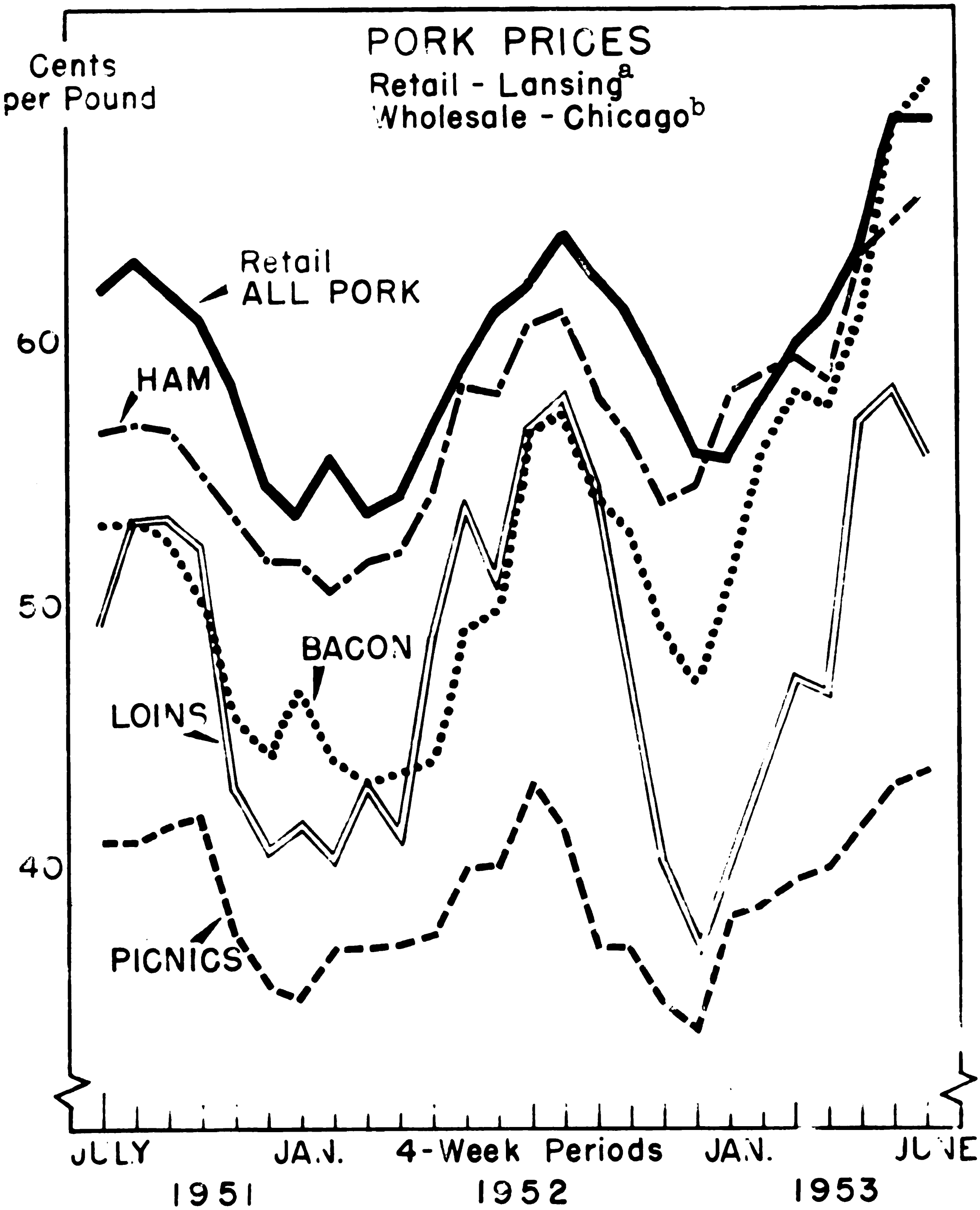
reached its peak in 1951 with market supplies and consumption rising to its highest level during late 1951 and early 1952. By early 1953 total pork supplies began to reflect a sharp cut-back in farm production. This caused prices to rise to the highest levels since 1948.

Wholesale pork prices on the Chicago market reflect the variations in supplies described above (Figure XVII). Prices of wholesale pork cuts reached their lowest levels during the winter of 1951-52. The highest prices during the two year period occurred in June 1953, when supplies were sharply curtailed.

Seasonal variations in retail pork prices closely paralleled the variations in wholesale pork prices. The seasonal peak in prices occurred during late August and early September in both 1951 and 1952, with the low coming during December, January, and February. Prices of fresh pork loins showed more variability than did cured items such as ham and picnics.

During early 1953, sharp price increases were noted on all pork cuts, but the increase in bacon prices was particularly noticeable. Retail prices of all pork tended to lag behind the wholesale price increases and as a result the retail margin on pork was sharply reduced during late May and June of 1953.

A scatter diagram of pork purchases by panel families,



[a] M.S.C. Consumer Panel

[b] Wholesale Dressed Meat Prices: Weekly Average of Daily Quotations, taken from <u>Weekly Market Reviews and Statistics</u>, Livestock Br., P.M.A., W.S. Dept. of Agr.

Ham - cured, ch., smkd., skd., 12-16 lb. ave.
Bacon - cured, ch., sliced, 1 lb. pkg.
Loins - fresh, ch., 10-12 lb. ave.
Picnics- cured, ch., smkd., 4-8 lb. ave.

Figure XVII. Comparison of retail pork prices in Lansing with prices for selected wholesale cuts in Chicago, four week averages, July 1951-June 1953.

plotted against weekly average prices, was made to study basic relationships existing between those variables (Figure XVIII). It was rather obvious that quantities purchased were systematically related to variations in price. Most of the observations were clustered within an area bounded by prices of 54 to 64 cents per pound. Within this area there was a great deal of variation in purchases associated with any given price. Closer inspection of the plotted observations revealed that there may have been some horizontal shifts in the price-quantity relationship. For the last half of 1951 the line of average relationship appears to be shifted to the right. There are logical reasons why this occurred. This was a period during which supplies of other red meats were small (Table 16, page 125) and prices for beef were at a high level. It was also a period during which beef prices were under the control of OPS. It seems reasonable that under these circumstances the demand for pork would increase.

During 1952 and the first half of 1953, the decline in beef prices probably caused the demand function for pork to shift to the left. If beef and pork are competitive, this would account for some of the dispersion in the observations shown in Figure XVIII.

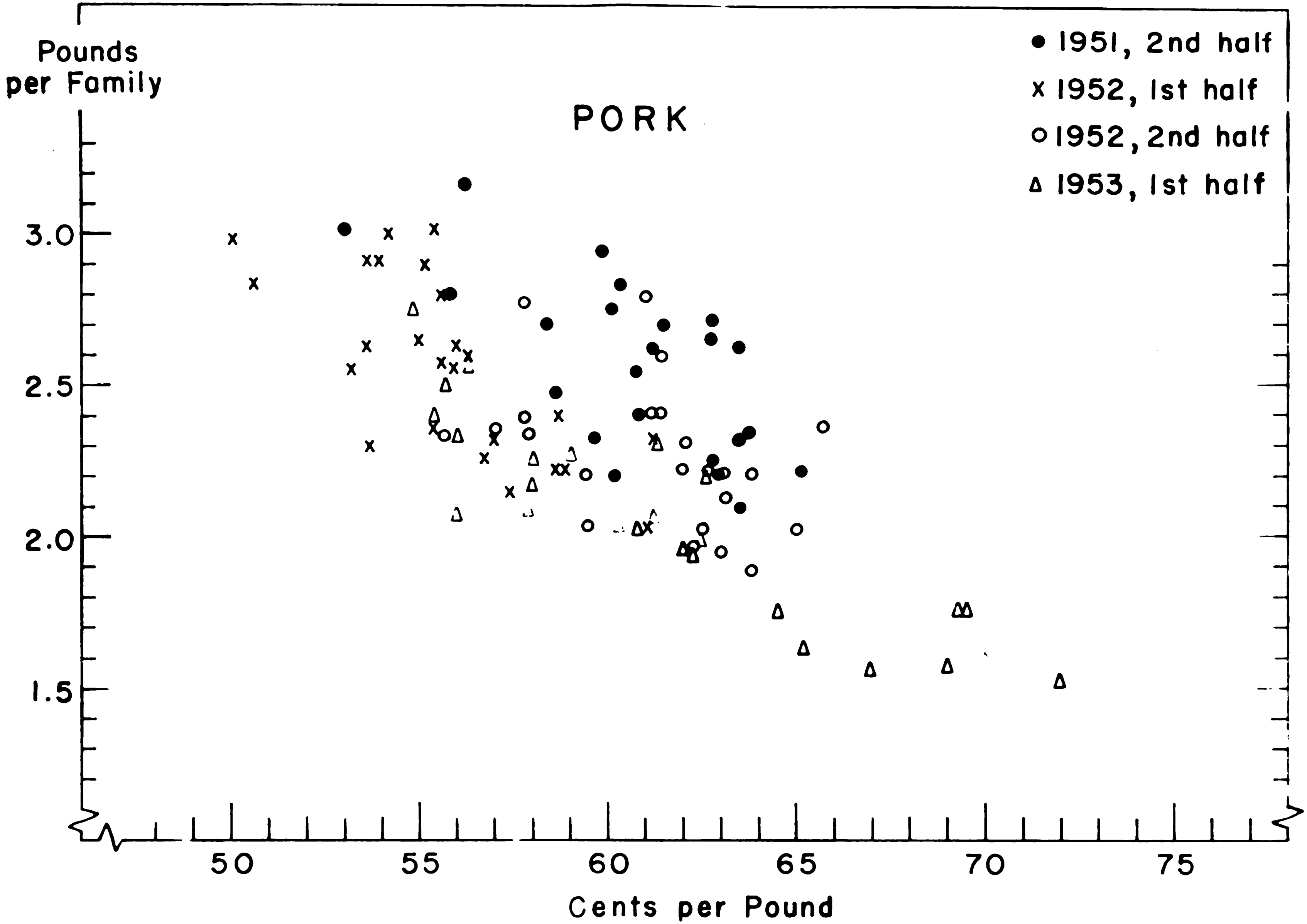


Figure XVIII. Relationship between weekly average purchases and prices of pork, M.S.C. Consumer Panel, July 1951-June 1953, holidays omitted.

More detailed plotting of the pork purchases as related to prices revealed that shifts in the demand function may have occurred between summer and fall periods. This would be logical if there were a significant decline in demand for pork during the summer months.

The sharp rise in prices in the spring and early summer of 1953 was the beginning of a period of high pork prices which extended into 1954. Data available for this study cover only the beginning of this period; however, it can be observed in Figure XVIII that consumers responded rather quickly to the rise in prices. Quantities purchased declined far below those of other weeks in the two year period covered by this study. These adjustments in pork purchases and prices occurred during a period in which beef supplies had soared to record levels causing the retail price of beef to fall sharply. The sudden rise in pork price, while beef prices were making their downward adjustment, suggests that many consumers are reluctant to substitute beef for pork. Purchase data for both beef and pork give indications that substitutability between these two meats is far from perfect. Analysis of data over a longer period which includes the last half of 1953 and 1954 will provide a more adequate basis for testing some of these relationships.

Results of Regression Analysis

July 1951-December 1952. Following similar procedures used in analyzing the demand for beef, a single equation model was fitted to the pork purchase data for the 18 monthperiod beginning July 1, 1951. The weekly average purchases of pork were taken as a function of the prices of beef, pork, sausage, poultry, fish and family income. Data for the major holiday weeks were omitted.

The simple correlation between the quantity of pork and the price of pork was 0.59. The simple correlations between the quantity of pork and the prices of "competing" meats and family income were all non-significant at the 5 percent level. The correlation with the price of beef was .21 which approaches significance at the 5 percent level. (With 70 d.f. a correlation coefficient of .23 is significant at the 5 percent level.)

The equation was fitted to the data in arithmetic form. The mathematical fit by least squares yielded an R of .684 and a standard error of estimate of .223 pounds; the mean was 2.47 pounds. The multiple regression coefficient was not a great deal larger than the simple correlation between the quantity and price of pork taken alone.

The prediction equation was as follows:

$$(2.1)\ Y_2 = .3780 + .0199X_1 - .0563X_2 + .0315X_3 + .0232X_4 + .0091X_5 + .0039X_6$$

The signs of all the coefficients were consistent with expectations based upon *a priori* reasoning. Casual inspection indicates that the price of pork, X_2, is the most important variable in the equation explaining weekly pork purchases. To further compare the relative importance of these variables, beta coefficients were computed and tested for significance. (See Table 25.) Only the price of pork was significant at or above the 5 percent level. Income was the least important variable in the equation.

The price elasticity of demand for pork measured at the mean was -1.35, indicating an elastic demand. The largest cross elasticity of demand was with sausage meats, with beef and poultry following in that order of importance.

These above computations provide tentative estimates of the structural relationships between the average weekly pork purchases by Lansing families and the explanatory variables in the regression equation. The "low" multiple regression coefficient suggests, however, that all the explanatory variables have not been taken into account. It is also possible that some function other than a linear function in absolute arithmetic values could better fit the data.

An examination of the pattern of residuals provides a basis for judging the adequacy of the single equation model used in this problem (Figure XIX).

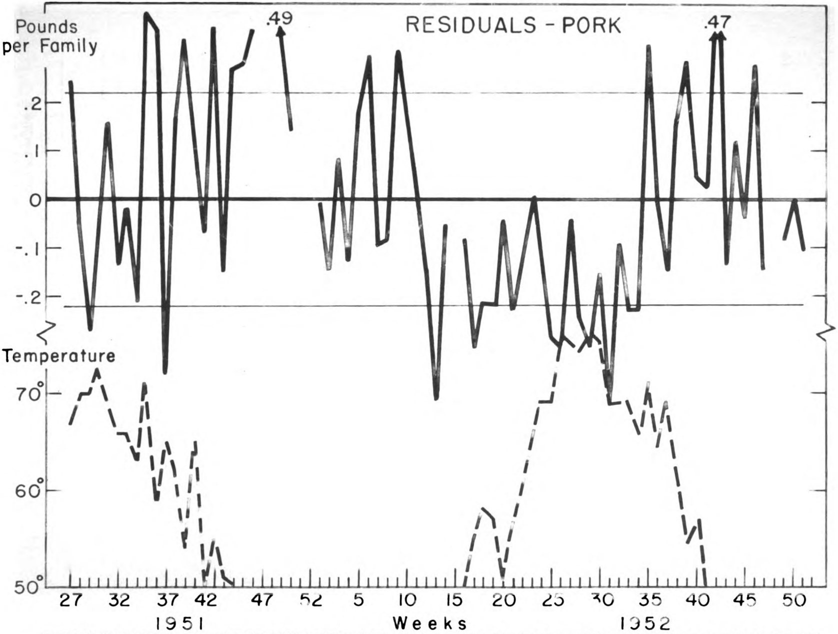


Figure XIX. Residuals from pork equation (2.1) compared to weekly average of mean daily summer temperatures in Lansing.

The residuals for the pork equation (2.1) show a seasonal pattern similar to that observed for beef. Temperature was correlated with the pork residuals.[1] For the warm season weeks a correlation of -.35 existed. For the entire July 1951-December 1952 period, the correlation was -.31. The regression coefficients for these two groupings of weekly data were almost the same where pork residuals were expressed as a linear function of the temperature variable. For the warm season weeks, the regression coefficient was -.0149 and for the entire period (July 1951-December 1952), the co-efficient was 0.137. The t ratio for this latter coefficient was 2.73 which was highly significant.

TABLE 25

SUMMARY OF REGRESSION RESULTS, PORK EQUATION
JULY 1951-DECEMBER 1952

Statistical Measure	Variables					
	Price of Beef X_1	Price of Pork X_2	Price of Sausage X_3	Price of Poultry X_4	Price of Fish	Income
Beta's	.1363	-.6921	.2145	.1370	.1192	.0727
σ_β	.1362	.1091	.1138	.0950	.1010	.5500
t value	1.37	6.34	1.88	1.97	1.18	.55

[1] The temperature variable was coded as actual mean temperature in Lansing-60 with all temperatures of less than 60 given a value of zero.

July 1952-June 1953. After data became available for the first half of 1953, a separate regression analysis was made for the period July 1952 to June 1953. This was a period of substantial price changes for both pork and beef. The same basic demand equation was used as described in the preceding section, with one exception. The four-week moving average of family income was replaced by a thirteen week moving average. Major holiday weeks again were omitted from the series of observations.

The prediction equation fitted to the data was as follows:

$$(2.2)\ Y_2 = 5.3547 + .0055X_1 - .0560X_2 - .0016X_3 + .0043X_4 + .0113X_5 - .0166X_6.$$

An R of .82 and a standard error of estimate of .314 were associated with this equation. The mean quantity was 2.17 pounds. The signs of two variables, sausage as X_3 and income as X_6, were changed from those obtained in equation (2.1). However, neither of these coefficients was significant (Table 26). The coefficient for X_2, the price of pork, was highly significant and was approximately the same as the previous estimate in equation (2.1). The coefficient for the price of beef was considerably smaller and the level of significance was reduced from the previous estimate.

Since the income variable proved to be non-significant and was intercorrelated with beef prices it was decided to drop it and compute a new prediction equation.

$$(2.3)\quad Y_2 = 3.2096 + .0180X_1 - .0544X_2 + .0041X_3 + .0037X_4 + .0110X_5$$

The multiple R for this equation was .82, essentially unchanged from the previous equation. The sign changed for sausage price, X_3, but the coefficient was still non-significant. The coefficient for the price of beef changed substantially and became significant at the 1 percent level. The coefficient for the price of pork, X_2, was practically unchanged from equation (2.2) and (2.1).

Using the coefficients for the last equation the price elasticity of demand for pork would be estimated at approximately -1.53 at the mean values of price and quantity. The cross elasticity of demand with the price of beef was .53, indicating that a 10 percent change in the price of beef was associated with a 5.3 percent change in pork purchases in the same direction. This again applies to changes at the mean values, assuming prices of other meats are held constant.

The apparent relationship between temperature and pork purchases was mentioned earlier. When added to a multiple regression, temperature proved to be significant in explaining the seasonal shifts in demand for pork Equation (2.4) summarized the results of this analysis:

$$(2.4)\ Y_2 = 1.5359 + .0241X_1 - .0442X_2 + .0114X_4 + .0115X_5 + .0091X_6 - .0160X_8$$

The multiple regression coefficient was .91, the highest obtained for any of the pork equations. The standard error of estimate was .164 pounds and the mean quantity was 2.17. The temperature coefficient indicated that a 10 degree increase in the weekly average of mean daily temperatures, above the 60 degree level, was associated with a decrease of .136 pounds (about 7½ percent) in pork purchases per family. There were also some noticeable changes in some of the other regression coefficients. The coefficient for X_2, the price of pork, was smaller than any of the previous estimates from other equations. The coefficient for X_1, the price of beef, was the largest obtained from any of the equations. Although there were some changes in the coefficients for prices of other competing meats, none approached significance (Table 26). Measured at the mean values, the price elasticity for pork was -1.25 and the cross elasticity with the price of beef was .71. In absolute terms, an increase of 5 cents per pound in the price of pork was associated with a decrease of .22 pounds in average weekly pork purchases per family. A decrease of 5 cents per pound in the price of beef was associated with a decrease of .12 pounds in average weekly pork purchases per family.

Summary. The results from the pork regression analyses were more consistent than those for beef. The coefficients for X_2, the price of pork, ranged from -.0444 to -.0563 with the lower estimate coming from equation (2.4) where temperature was used as a demand shifter. Intuitively, the -.0444 coefficient seemed to be superior to the higher estimates which may be biased by seasonal shifts in demand.

TABLE 26

SUMMARY OF REGRESSION RESULTS, PORK EQUATIONS, JULY 1952-JUNE 1953

	Variables					
Statistical Measure	Price of Beef X_1	Price of Pork X_2	Price of Sausage X_3	Price of Poultry X_4	Price of Fish X_5	Family X_6
Equation (2.2)						
Beta's	.1160	-.7512	-.0013	.0361	.1450	-.3006
σ_β	.3225	.1164	.1399	.1006	.0984	.3393
t values	.36	6.45	.08	.36	1.47	.89
Equation (2.3)						
Beta's	.3794	-.7293	.0292	.0309	.1420	
σ_β	.1262	.1148	.1335	.1014	.0992	
t values	3.01	6.35	.22	.31	1.43	
Equation (2.4)						
Beta's	.5080	-.5931	.0811	.0956	.1174	-.2814*
σ_β	.1329	.1246	.1293	.1007	.953	.1226
t values	3.82	4.76	.63	.95	1.23	2.30

* Temperature variable, noted as X_7 in Equation (2.4)

The coefficient for X_1, the price of beef, ranged from .0055 to .0241, but the lower estimate was rejected because of the disturbing influence of the intercorrelation between beef prices and the income variable in equation (2.2). Therefore, the reasonable range of estimates for X_1 lies between .0180 and .0241 with some preference for the higher coefficient where seasonal shifts in demand were partially accounted for in the regression equation.

Although none of the coefficients for sausage or poultry prices was significant at the 5 percent level, it appears reasonable that mild substitutability does ~~not~~ exist between pork and these items.[2] In most instances this was indicated in the regression results.

The use of a temperature variable provided a reasonably satisfactory procedure for measuring the influence of changing demand between the warm and cool seasons of the year. It was surprising to find the temperature coefficient for pork was less than the corresponding coefficient in the beef equation. This relationship should be tested by analyzing data over a longer time period where several seasons can be observed.

---

[2] In a recent study R. C. Smith found some evidence that fryers and pork loins were competitive. See Factors Affecting Consumer Purchases of Frying Chickens, University of Delaware, Agr. Exp.Sta. Tech. Bul.298, Newark, Delaware 1953, p.7.

Demand for Selected Retail Cuts

Preliminary analysis of panel data on retail pork cuts indicates that the demand for pork chops and ham is elastic with respect to price-quantity relationships, while the demand for bacon is slightly inelastic. These generalizations apply to the period July 1952 to June 1953 without fully accounting for the effects of changing prices for beef or possible seasonal shifts in demand. Further refinements in methods of measurement will be required to obtain reliable estimates for the true structural price-quantity relationships.

Weekly average price, percent of families buying, quantities, and expenditures per family for several pork cuts were plotted on semi-logarithmic paper to study the interrelationships among these variables. Prices and expenditures for pork chops were inversely related indicating an elastic demand. A simple correlation of 0.76 existed between the weekly average prices of chops and quantities purchased per family. This was based on 49 weekly observations, with the major holidays being omitted. A two variable regression with quantities purchased expressed as a function of weekly average prices yielded a regression coefficient of -.0059. The price elasticity was -1.33 at the mean values of 74.3 cents per pound for price and .332 pounds per family for quantity. From the graphs, mentioned above, there appeared to be a significant inverse relationship between the prices of pork chops and the percent of families buying. During the second quarter of 1953, when prices rose from 70 cents per pound to 89 cents, the percent of families buying declined from about 27 percent to 18 percent. These observations provide the basis for a tentative conclusion that the demand for pork chops was elastic for the period studied.

Graphical examination of purchase data for fresh pork sausage indicated that prices for this commodity did not increase in proportion to prices for other fresh pork items during the first half of 1953. Nevertheless, expenditures for sausage and quantities purchased varied considerably and inversely with prices. Does this mean, then, that the demand for pork sausage is highly elastic? Probably not in this case, since there is reason to believe that the demand for fresh fat pork cuts declines significantly from winter to summer. The period of large supplies and low prices for these items occurs during the winter when demand is seasonally strong. As summer approaches, demand declines seasonally, while at the same time, total pork supplies decline and prices tend to rise. Under these conditions fitting a line of average relationship to prices and quantities observed in the market over time, is likely to yield a demand function having much greater elasticity than the true demand function.

This same general relationship, described for pork sausage, appears to be true for pork roasts.

For both pork sausage and roasts, the percent of families buying varies widely by seasons of the year. During the winter, about 17 to 20 percent of the families bought sausage in any given week. The percentage declined to around 12 during the summer. The quantity of sausage purchased is closely related to the percent buying with the average purchase being slightly over one pound. The percentage of families buying pork roasts was around 10 percent during the winter, while only 5 to 6 percent purchased during the summer. These variations in percent of families buying suggest that sizable shifts in demand may have occurred. Further research will be required to verify this.

Ham and bacon are the two most important cured pork items with each having somewhat different demand characteristics. Bacon is primarily a breakfast item; as such, it is doubtful that other meats are readily substituted for it in the average household. Pork sausage and ham are probably substitutable for bacon to a limited extent. Under these conditions it would be expected that the demand for bacon might be inelastic. The purchase data from the M.S.C. Consumer Panel seems to verify this hypothetical relationship. During the period July 1952-June 1953, expenditures for bacon were positively related to weekly average prices. A simple correlation of -.50 existed between weekly average quantity purchased per family and price. A linear regression of quantity as a function of weekly average prices yielded a regression coefficient of -.0061. At the mean value of price (55.9 cents) and quantity (.452 pounds) the price elasticity of demand was -.75.

The price elasticity for ham for the 1952-53 period appeared to be elastic. Due to wide weekly fluctuations in purchases it is difficult to determine the true structural relationships from a simple function involving only price and quantity in the current week. From the graphs of the data, it appears that weekly expenditures per family are negatively related to price. This suggests that the price elasticity of demand is greater than one. A linear regression with weekly ham purchases as a function of price indicated an elasticity of -1.36 at the mean values of these variables. The mean price was 70.6 cents and the mean quantity was .43 pounds per family per week for the July 1952-June 1953 period. The simple correlation between weekly average prices and quantities of ham purchased was -.46.

It is interesting to note that the percent of families buying ham remained relatively constant throughout the period of rising prices in the first half of 1953. This would suggest that families were continuing to buy ham as frequently as previously, but the size of purchase was declining as prices increased.

In summary, it appears that the demand for some of the fat pork cuts may shift considerably from winter to summer. If this is true, market data may provide estimates of price elasticity of demand that are biased upward because the seasonal shifts in demand tend to accentuate the normal response to seasonal price changes. This would also bias some of the demand elasticities for "all pork" discussed earlier in this chapter. Further research with data over a longer period will be required to determine the "true" structural relationships between prices and quantities of retail pork cuts.

CHAPTER VIII

THE DEMAND FOR SAUSAGE, POULTRY AND FISH

Introduction

Although sausage meats, poultry, and fish can be classified as minor meat groups, they collectively account for about 30 percent of the total quantity of meat purchased by M.S.C. Consumer Panel members (Table 15, page 120). Average weekly purchases of sausage were 1.12 pounds per family during the period July 1951 to June 1953. This is slightly less than the 1.24 pounds of poultry purchased by panel members and is more than twice as large as the average weekly purchases of fish.

In the preceding chapters an attempt was made to measure the extent to which these "minor meats" are competitive with beef and pork. Results indicated that prices of sausage, poultry, and fish had relatively little effect in shifting the demand for beef and pork. This does not mean, however, that the prices and purchases of beef and pork have no appreciable effect on the demand for each of the minor meat groups. In this chapter demand for sausage, poultry, and fish will each be discussed individually.

The Demand for Sausage Meats

As defined earlier, sausage includes weiners, frankfurters, bologna, salami and cold cuts of all descriptions. It also includes meat mixtures of various kinds, but these make up only about 20 percent of this meat grouping (Table 27).

There appeared to be little relationship between weekly average prices and the quantity of sausage purchased. (Figure XX). A simple correlation of -.089 existed between prices and quantities for the period July 1951-December 1952. A multiple regression analysis was made.

TABLE 27

SUMMARY OF PURCHASE DATA FOR DIFFERENT SAUSAGE MEATS, M.S.C. CONSUMER PANEL, JULY 1952 - JUNE 1953.

Product	Weekly Averages*			
	Average Price	Quantity per Family	Expenditure per Family	Percent Buying
	cents per pound	pounds	cents	
Weiners and franks	59	.31	18	29
Bologna and salami	59	.26	16	27
Cold cuts	73	.24	17	26
Other**		.28		
Total	59	1.09	64	

* Holiday weeks omitted.

** Other includes Prem, Spam. Treet, chop suey meat, chili con carne, hash, soup and mincemeat.

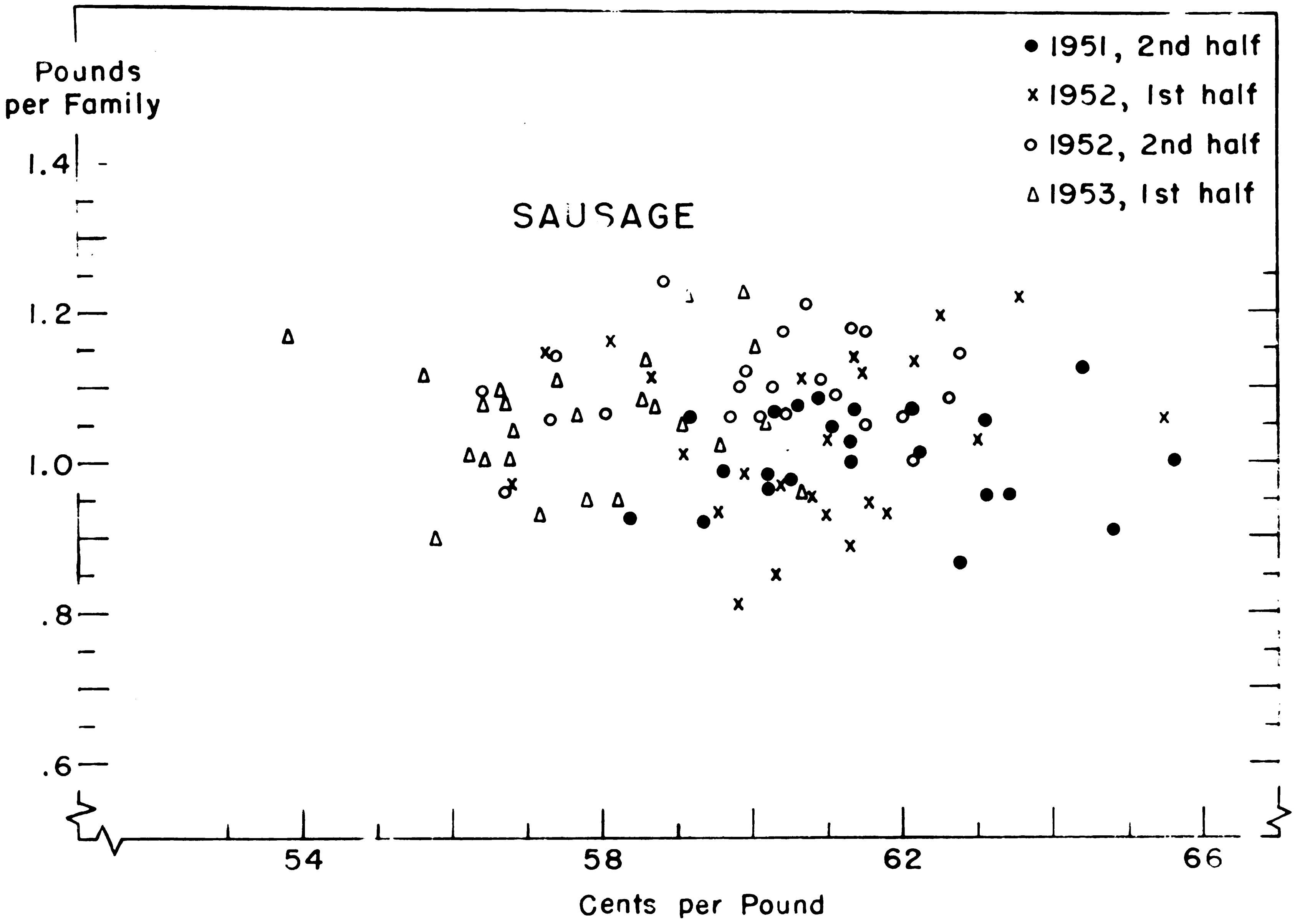


Figure XX. Relationship between weekly average purchases and prices of sausage, M.S.C. Consumer Panel, July 1951-June 1953.

Sausage purchases were expressed as a linear function of sausage prices, current family income and the prices of other meat groups. This yielded an R of .60. The standard error of estimate was .073 with a mean of 1.05 pounds per family per week. The prediction equation was as follows:

$$(3.1)\ Y_3 = 1.3208 - .0063X_1 + .0117X_2 - .0036X_3 - .0097X_4 + .0001X_5 + .0024X_6$$

Here again the price of sausage, X_3, had a non-significant influence on weekly average purchases of sausage meats. The most important variable affecting sausage purchases was the price of pork. The regression coefficient indicates that a change of 5 cents per pound in the price of pork was associated with a change in the same direction of .058 pounds in the average weekly purchases of sausage meats. This relationship with pork prices must be viewed with caution, however, since seasonal shifts in demand, rather than changing prices of pork, may be responsible for the statistical results obtained. The demand for pork is strongest during the fall and early winter and weakest during the summer. The seasonal pattern of demand for sausage meats is about the opposite of the pork demand pattern with both being a function of temperature and other seasonal factors. This common relationship is probably the principal reason why purchases of sausage meats show a significant regression relationship with pork prices. This is not to say that there is no competition between pork and sausage meats. It seems reasonable that ready-to-eat ham would be quite competitive with cold cuts.

The price of poultry showed a significant regression relationship with sausage purchases; however, the negative sign would indicate a complementary relationship. This seems illogical since it implies that a decline in the price of poultry is accompanied by an increase in sausage purchases, other things remaining the same.

This relationship may be partially attributed to seasonal shifts in demand. For the period studied, the seasonal increase in cold meat purchases during late spring and early summer closely paralleled a downward trend in poultry prices. The decline in poultry prices was largely due to increasing supplies of poultry meats. Therefore, it seems illogical to accept the regression coefficient between poultry prices and sausage purchases unless it is supported by data over a longer period of time.

The residuals from the prediction equation described above indicate that there is a seasonal shift in demand for sausage meats with demand being strongest during the summer months (Figure XXI). This would be expected since cold meats are popular for picnics and are easily prepared for the table during hot summer weather. A correlation of .24 existed be-

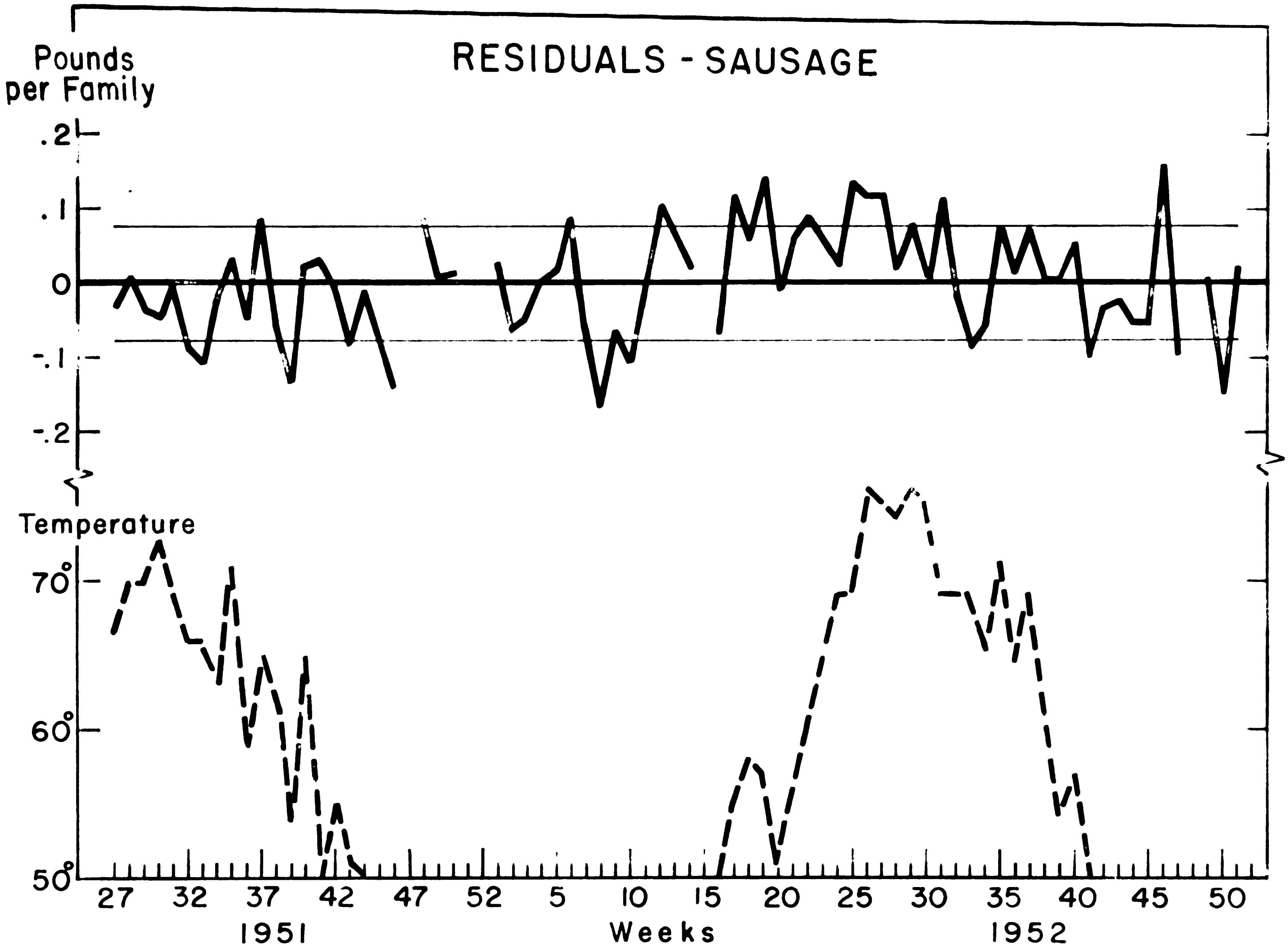


Figure XXI. Residuals from sausage equation (3.1) compared to weekly average of mean daily summer temperatures in Lansing.

tween the residuals and temperature during the warm season of the year. A regression analysis for this same period of time indicated that a 10 degree increase in the weekly average of mean daily temperatures would be accompanied by an increase of .031 pounds in sausage purchases.

In conclusion, this analysis indicated that consumer purchases of sausage items do not respond significantly to changes in the sausage prices. The interrelationship of sausage purchases to prices of pork and poultry are not clear based on the above regression results.

A regression analysis, using data for a later period, also yielded "negative" results. Weekly sausage purchases were expressed as a function of sausage prices, temperature and the prices of other meat groups. The prediction equation was as follows, based on weekly observations for the July 1952-June 1953 period:

$$(3.2)\ Y_3 = .4148 - .003X_1 + .0060X_2 + .0043X_3 - .0019X_4 + .0028X_5 + .0014X_7$$

X_7 was the temperature variable. The multiple regression coefficient was .24. None of the beta coefficients approached significance, even at the 5 percent level. The simple correlation between temperature and sausage purchases was only .15.

A tentative conclusion was that purchases of "sausage," as aggregated for this study, have practically no relationship to the variables used in the regression analysis. Further analyses should give greater attention to a study of smaller sub-groups of sausage items.

The Demand for Poultry Meats

The analysis of panel data on purchases of poultry meats was limited to the overall meat group with little or no attempt to study the demand characteristics of particular kinds of poultry. In any given week, approximately one-third of the panel families buy some kind of poultry meat. Poultry expenditures made up about 12 percent of the total meat bill over a two-year period. Table 23 shows that chicken meat made up about 72 percent of total poultry purchases for the period July 1952-June 1953, omitting holidays. Fryers are by far the most important chicken product with stewing chickens and roasters following in order of importance. Turkey purchases are quite small mostly because Thanksgiving and Christmas weeks are omitted from the tabulation. Actually about 73 percent of the 1952 turkey purchases were made in these two holiday weeks.

Inspection of a scatter diagram of weekly average prices and family purchases for all poultry meats (Figure XXII)

TABLE 28

RELATIVE IMPORTANCE OF DIFFERENT KINDS OF POULTRY MEATS, M.S.C. CONSUMER PANEL, JULY 1952-JUNE 1953

Product	Weekly Averages[a]			
	Price	Quantity per Family	Expenditure per Family	Percent Buying
	cents per pound	pounds	cents	
Chicken				
Broilers or fryers	57	.40	23	12.0
Stewing	51	.25	12	6.2
Roasters	50	.12	6	2.4
Other[b]	57	.04	2	3.5
Turkey	79	.06	4	1.3
Other[c]		.25		
Totals	52	1.12	58	

a Holiday weeks omitted.
b Includes chicken parts, canned chicken and chicken pie.
c Includes duck, and mixtures, chiefly chicken.

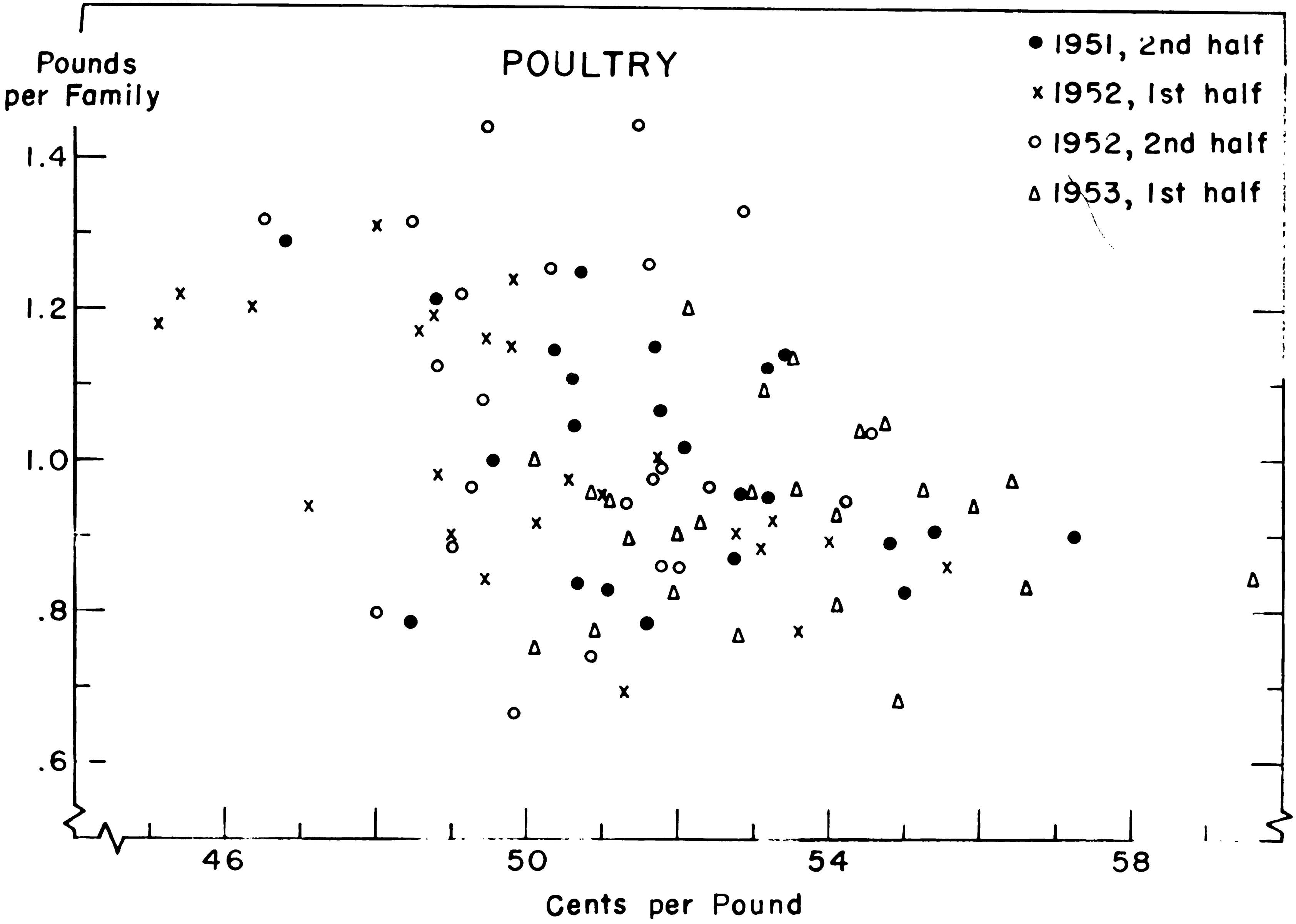


Figure XXII. Relationship between weekly average purchases and prices of poultry M.S.C. Consumer Panel, July 1951-June 1953, holidays omitted.

showed wide variability in quantities purchased for any given retail price. Part of this variation is due to the changes in the composition of the overall commodity from week to week. For example, in some weeks fryers make up an unusually high proportion of total purchases. This is likely to occur when fryers are featured as specials by some of the large chains. Variations in average relationships between prices and quantities may also be caused by lack of refinement in processing the data. In this study, no attempt was made to convert each poultry purchase to some standard basis such as "ready-to-cook" weight.[1]

The large shifts in demand for poultry associated with the Thanksgiving and Christmas holidays were discussed in Chapter V. The effects of these holidays have not been completely removed from the data by omitting the weeks during which the holidays occurred. Close examination of the data indicates that the demand for poultry meats tends to be depressed during the weeks before and after Thanksgiving.

For the period July 1951-December 1952, there was a correlation of -.40 between the weekly average quantities of poultry purchased per family and the city-wide average price. A seven variable multiple regression with the quantity of poultry purchased as the dependent variable yielded an R of .58. The standard error of estimate was .148 pounds per family with a mean of 1.022. The prediction equation

---

[1]In the food purchase diary poultry purchases are classified as alive, dressed, ready-to-cook, boned or selected parts. See page 10 of the diary in Appendix.

was as follows:

$$(4.1)\ Y_4 = .3128 - .0018X_1 + .0176X_2 + .018X_3 - .0288X_4 - .0029X_5 + .0041X_6$$

The price of poultry and the price of pork were both significant explanatory variables with the price of poultry being the most important according to a comparison of the beta coefficients (Table 29). The regression coefficients indicate that a change of 5 cents a pound in the price of poultry meat is associated with an opposite change in quantity purchased of .144 pounds. The price elasticity measured at the mean was -1.43.

The cross elasticity of demand with respect to pork prices was 1.02. This was about the same as the cross elasticity of 1.08 with sausage meats. The corresponding beta coefficients were tested for significance, with the result being that the pork coefficient was significant at the one percent level ($t = 2.98$) and the sausage coefficient was significant at 10 percent level ($t = 1.63$). These cross elasticities may be biased upward by the interrelations in seasonal shifts in demand for these three commodities. This same problem was raised in the preceding section dealing with demand for sausage meats.

The residuals were computed for the regression equation described above (Figure XXIII). No definite seasonal pattern was apparent in these residuals. There were substantial deviations in the actual poultry purchases compared with the predicted quantities. Further research would be required to develop a more precise prediction equation. Attention probably should be centered more on different poultry items such as fryers, roasters and stewing chickens.

The Demand for Fish

Fish expenditures made up only 5.4 percent of the total meat purchases of panel families during the two year period beginning in July 1951. Nevertheless, an average of 39 percent of the families were buying some kind of fish each week. The group of products labeled as "fish" includes all fresh and processed fish and seafood. (See the purchase diary in Appendix.)

It was pointed out in the preceding sections of this manuscript that the price of fish has little influence on the purchases of other meat groups. Further analysis indicated that fish purchases are not greatly affected by changing prices of these other kinds of meats. There was a significant relationship between the price of fish and the quantity purchased each week (Figure XXIV). A correlation of

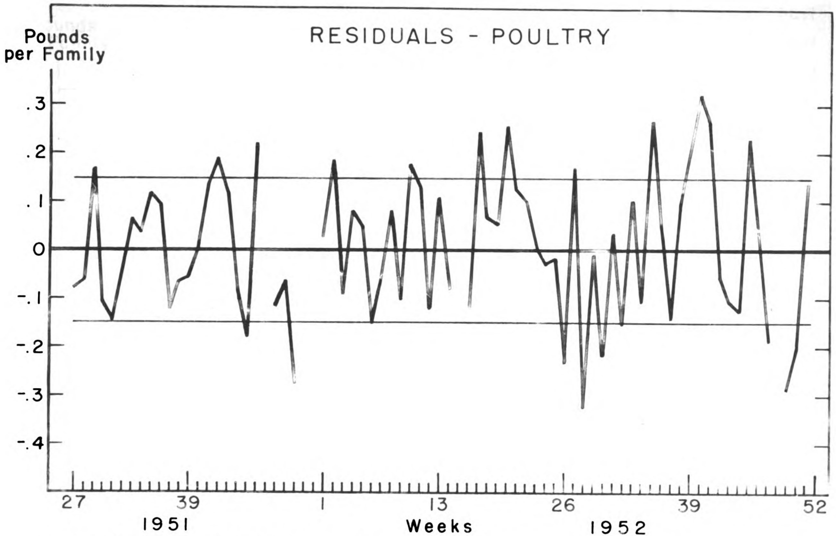


Figure XXIII. Residuals from poultry equation (4.1)

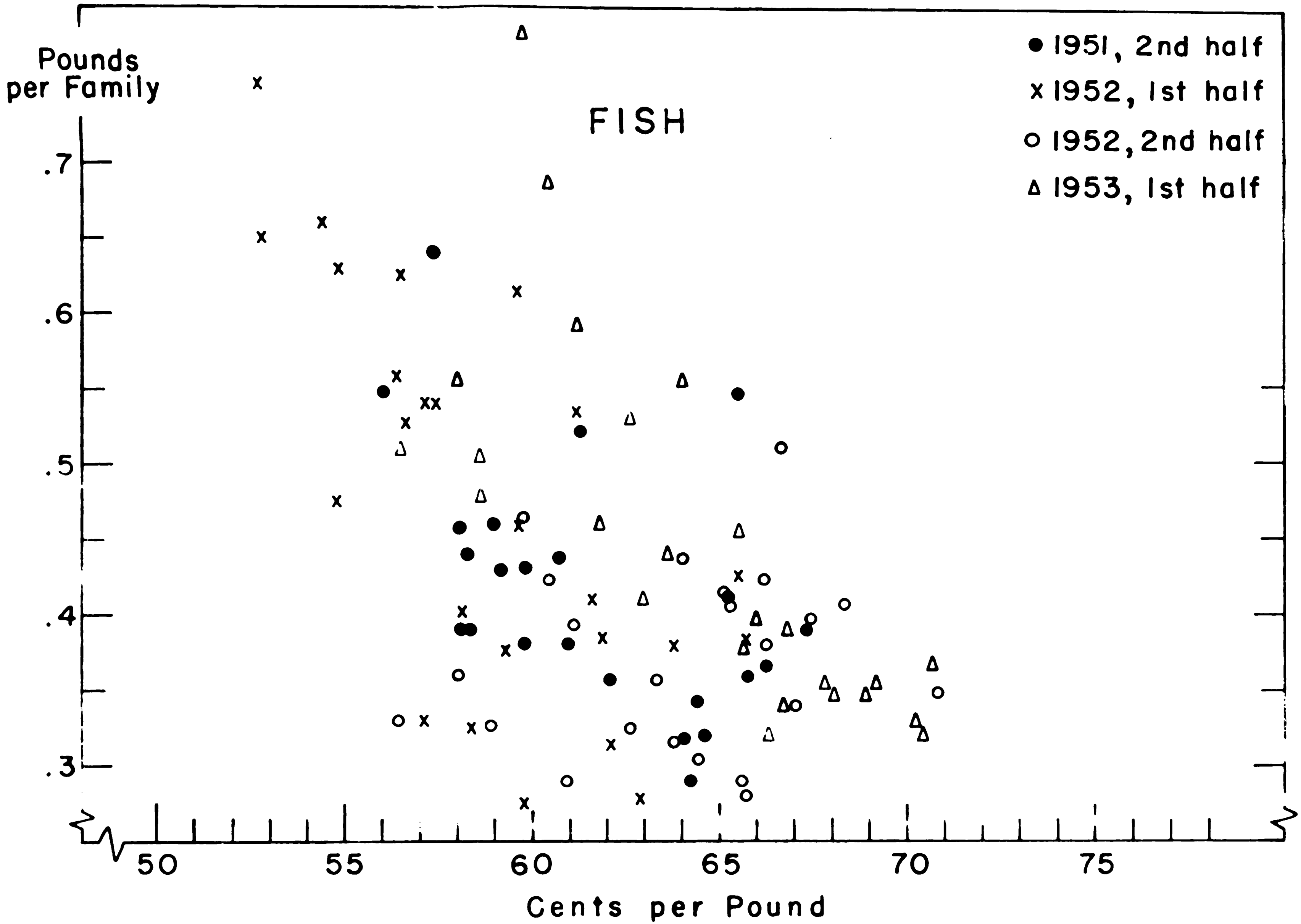


Figure XXIV. Relationship between weekly average purchases and prices of fish, M.S.C. Consumer Panel, July 1951-June 1953, holidays omitted.

-.57 existed between weekly average purchases and prices of fish for the period July 1952-December 1952. A multiple regression for this same period, with the quantity of fish as the dependent variable, produced an R of .65 and a standard error of estimate of .079. The mean quantity was .424 pounds. The prediction equation was a follows:

$$(5.1)\ Y_5 = 1.6203 + .0019X_1 - .0064X_2 - .0027X_3 - .0031X_4 - .0129X_5 + .0019X_6$$

The beta coefficient for the price of fish, X_5, proved to be highly significant at the 5 percent level (Table 29). Since the sign of the pork coefficient was negative, there is reason to doubt that this is a true structural estimate.

The residuals for the above equation show that purchases were greater than predicted during the Lenten period of 1952 and during the fall months of both 1951 and 1952 (Figure XXV). Purchases were less than the predicted amount during the summer months. This pattern supports the belief that the demand for fish increases during the Lenten period. The increase in demand during the fall months is probably part of an overall seasonal increase in demand for meats. The decline in fish purchases during the summer is probably related partially to the increased use of fresh fish caught in local lakes and streams and the general decline in demand for all meats.

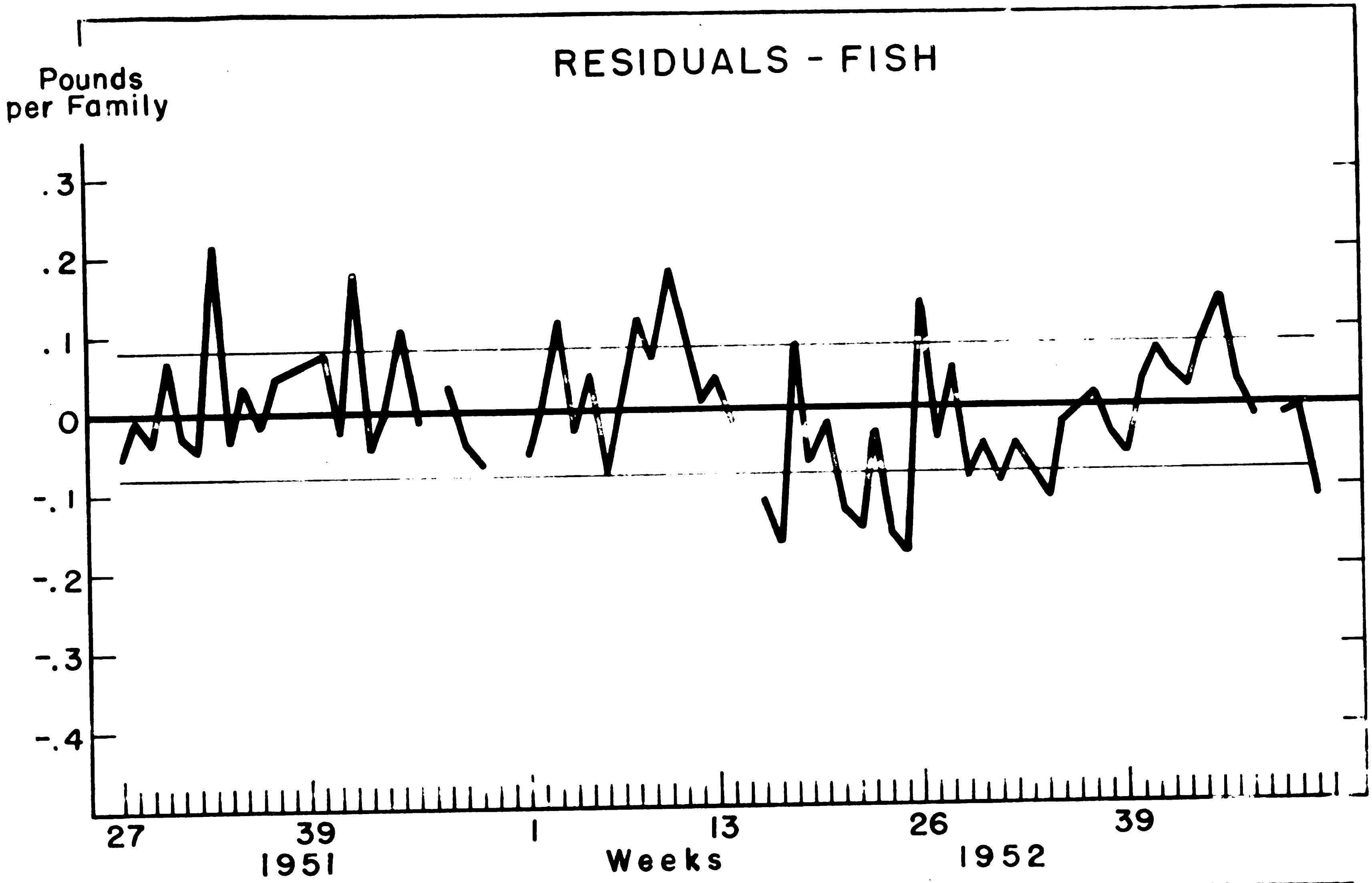


Figure XXV. Residuals from fish equation (5.1)

TABLE 29

SUMMARY OF REGRESSION RESULTS, SAUSAGE, POULTRY AND FISH,
M.S.C. CONSUMER PANEL DATA, JULY 1951 TO DECEMBER 1952

Product and Statistical Measures	Explanatory Variables								
	Price of Beef X_1	Price of Pork X_2	Price of Sausage X_3	Price of Poultry X_4	Price of Fish X_5	Income X_6	R	Sy.x	$\bar{Y}$
Y_3, Sausage									
b	-.0063	.0116	-.0036	-.0097	.0001	.0024	.60	.073	1.05
β	-.1996	.4797	-.0819	-.2608	.0032	.1495			
σ_β	.1496	.1198	.1249	.1042	.1152	.1444			
t	1.33	4.00	.66	2.50	.03	1.04			
Y_4, Poultry									
b	-.0018	.0176	.0132	-.0388	-.0029	.0041	.53	.148	1.02
β	-.0292	.3629	.2075	.3886	.0641	.1287			
σ_β	.1521	.1213	.1270	.1060	.1128	.1468			
t	.19	2.98	1.63	3.66	.57	.88			
Y_5, Fish									
b	.0020	-.0064	-.0027	-.0051	-.0129	.0019	.65	.079	.42
β	.0521	-.2320	-.0542	-.0743	-.4940	.1057			
σ_β	.1420	.1137	.1185	.0989	.1053	.1370			
t	.37	2.04	.46	.75	4.69	.77			

CHAPTER IX

THE DEMAND FOR ALL MEAT

Studies of the aggregate demand for all meats have been made by Working, Fox, Shepherd, and others. These studies were described earlier in this manuscript.[1] Based on annual data for the 1922-41 period, price elasticities of demand of approximately -.7 were reported. In these studies <u>all meat</u> was defined to include the red meats--beef, pork, veal, and lamb. Poultry and fish were excluded.

In this study all meat has been defined to include beef, pork, sausage meats, poultry, and fish purchased for home consumption. Veal and lamb were not included because of the small amounts purchased by panel families. The city-wide average price of all meat was computed as a weighted average. The sums of the expenditures for the various meat groups were divided by the sums of the quantities of different meats purchased. As the composition of the meat supply shifted toward more and lower priced beef in 1952 and 1953, the average price of all meats declined more rapidly than if a price index with base period weights were used in computing the average price.

---

[1] See Chapter III.

A scatter diagram of weekly average prices and pounds purchased per family showed rather wide variations (Figure XXVI). In spite of opposing trends in beef and pork prices, the average price for all meats declined from 66 cents per pound to 57 cents during the two year period, July 1951 to June 1953. The decline in prices appears to have been accompanied by increasing quantities of meat purchased, but the relationship is far from perfect. The correlation between weekly average prices and quantities for the two year period was -.52. A regression of quantity on price produced this prediction equation:

$$(6.1)\ Y_6 = 13.5787 - .0960X_1$$

Where Y is quantity and X_1 is price.[2] The price elasticity at the mean values of price and quantity was -.73. The standard error of estimate was .33 on a mean of 7.59 pounds per family per week.

When a thirteen week moving average of weekly family income was added as a third variable the multiple regression coefficient became .59. The prediction equation was as follows:

$$(6.2)\ Y_6 - 22.49302 - .1800X_1 - .0448X_2$$

The coefficients for price and income were both unreasonable.

---

[2] Major holiday weeks omitted.

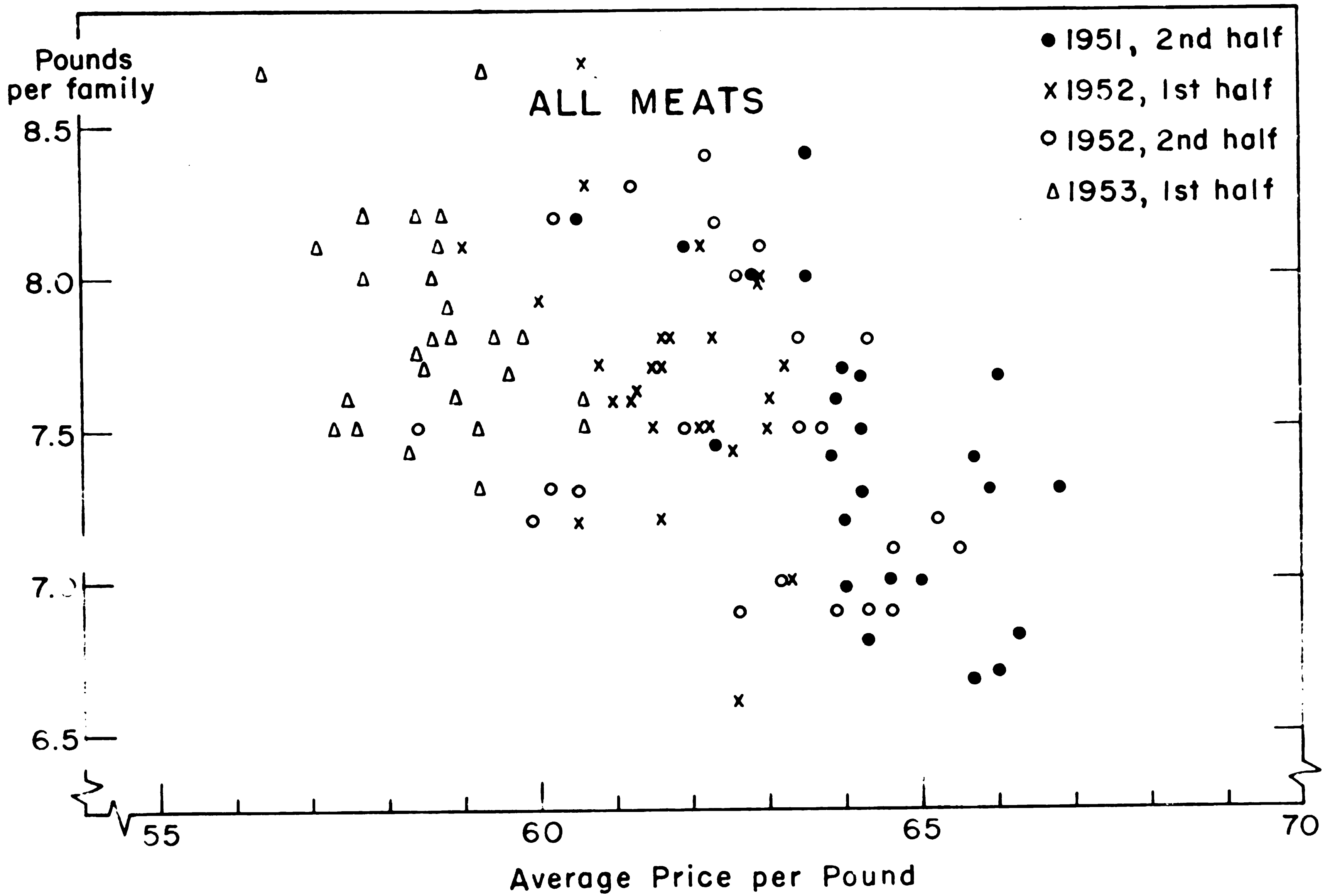


Figure XXVI. Relationship between weekly average purchases and prices of all meat, M.S.C. Consumer Panel, July 1951-June 1953, holidays omitted.

The price coefficient gave an elasticity of -1.46 at the mean values of price and quantity. The negative sign on the income coefficient was unreasonable since it indicated that a one percent increase in income was accompanied by a decrease of .5 percent in the quantity of meat purchased. The apparent difficulty in this regression was that an intercorrelation of -.86 existed between the price of all meats and the income variable.[3] It can also be observed that income and the price of meat both moved in opposite directions. When observations can be added over a period during which these variables move in the same direction the results may provide reliable estimates of the true structural relations.

The empirical results from the analysis of purchase data for pork, beef, and sausage meats confirmed some widely held beliefs with regard to seasonal shifts in demand for these items. The demand for all meats should reflect the summation of seasonal shifts in demand for the individual meat groups. An inspection of the weekly average purchases of all meats plotted over a period of two years showed rather pronounced seasonal variation. (See Figures VIII and IX, pages 93 and 94 .) After taking into account the relationship between price and quantity as found in equation (6.1), the residuals show substantial variation (Figures XXVII and XXVIII). A

3 Fox and Cooney, op.cit., pp.1-2.

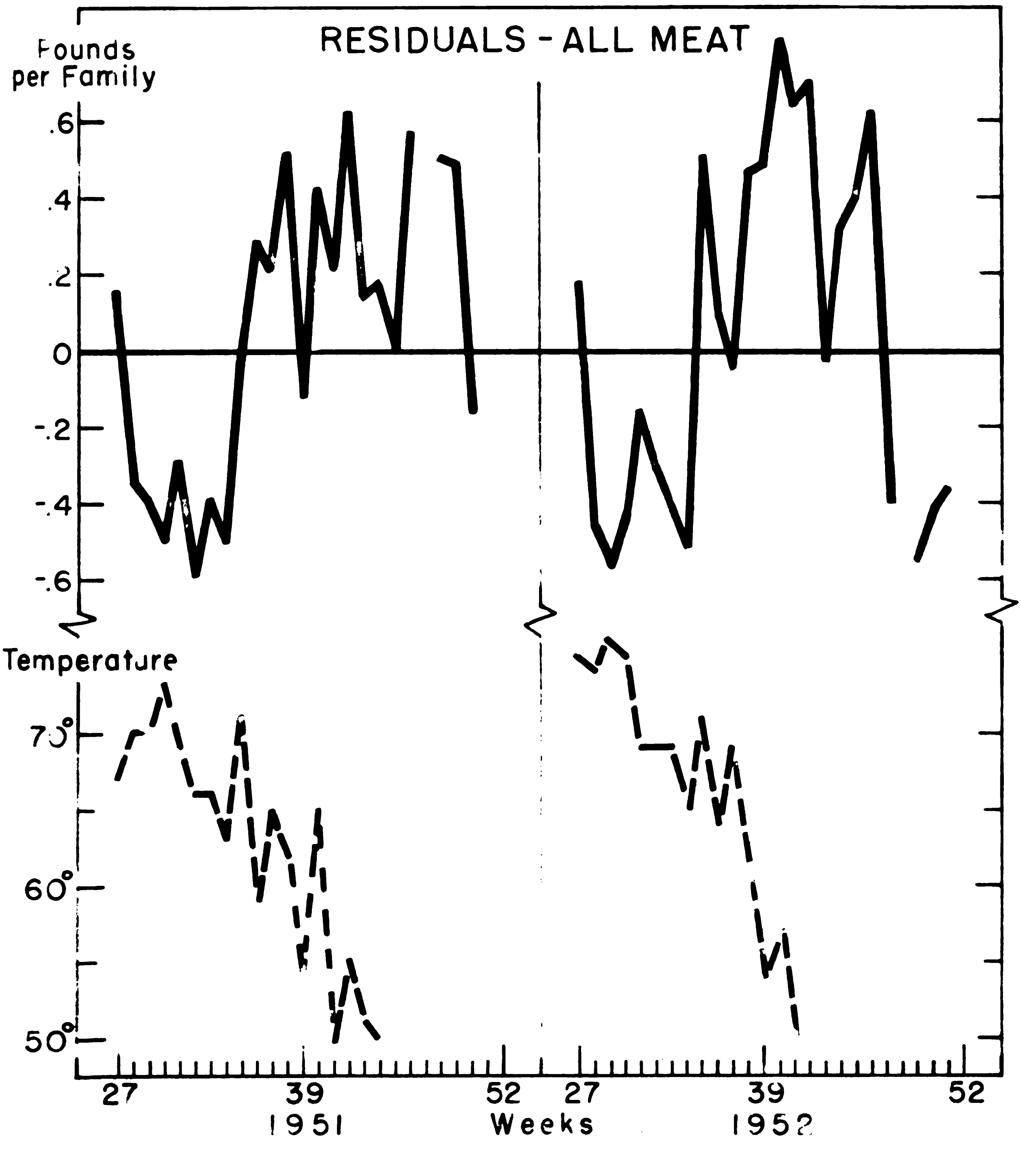


Figure XXVII. Residuals from equation (6.1) for all meats, last half of 1951 and last half of 1952; comparisons with summer temperatures.

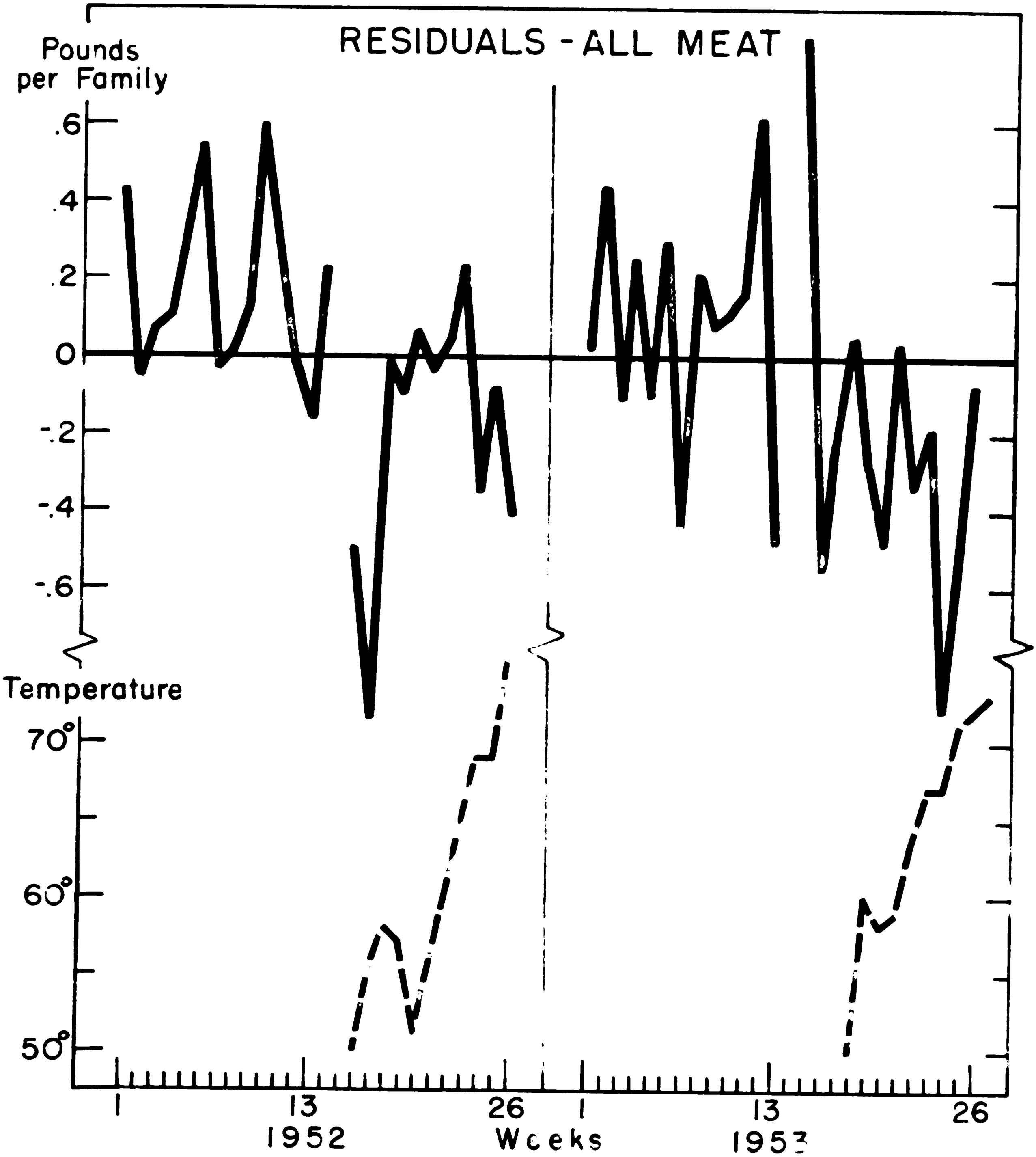


Figure XXVIII. Residuals from equation (6.1) for all meats, first half of 1952 and first half of 1953; comparisons with summer temperatures.

significant increase in demand appeared to have taken place around the first part of September during both 1952 and 1953. Demand remained strong throughout the fall and early winter with some downward adjustment occurring during the Lenten period, but this was relatively small (Figure XXVIII). The major downward shift in demand appears to begin after Easter. The decline in demand during the first two or three weeks following Easter is thought to be a result of the large purchases of ham for the holiday. Around the first of May demand begins to reflect the changes in eating habits associated with the summer season. The nature of these changes has already been described in previous sections.

It can be observed in Figures XXVII and XXVIII that temperature is related to the shifts in demand between summer and the fall-winter seasons. Using data for the summer season[4] a correlation of -.43 was found to exist between temperature[5] and the residuals as shown in Figures XXVII and XXVIII. Taking the residuals as a function of temperature a prediction equation was computed:

$$\text{Residuals} = 1.1271 - .0351 \text{ temperature.}$$

The regression coefficient indicated that a 5 degree increase

---

[4] Includes 51 weeks: 27-42 of 1951, 18-42 of 1952 and 17-26 of 1953.

[5] The weekly average of mean daily temperatures in Lansing with all weekly averages of 60 degrees or less given a value of zero and all temperatures above 60 degrees coded as T-60.

in temperature is associated with a .175 decrease in the residuals, which is expressed as pounds of meat per family per week.

Using the data for the entire two year period, July 1951-June 1953, a correlation between the residuals and temperature was found to be -.39. The prediction equation was:

$$\text{Residuals} = 1.0934 - .0319 \text{ Temperature}$$

The regression coefficient was highly significant with a t ratio of 4.13. It is also worth noting that the coefficients for both equations, relating residuals to temperature, were approximately the same.

Following the above analysis, temperature was added as a third variable to the regression equation (6.1). Using weekly observations for the period July 1951-June 1953, the following regression equation was computed:[6]

$$(6.3)\ Y_6 - 13.4727 - .0922\ X_2 - .0646\ X_T$$

The multiple correlation coefficient, R, was .67 as compared with the simple correlation of -.52 between price and quantity, X_2 and Y_6. The t ratios for the beta coefficients were both highly significant (Table 30).

---

[6] Holiday weeks were omitted, leaving a total of 97 weekly observations.

TABLE 30

SUMMARY OF REGRESSION RESULTS, EQUATION (6.3), ALL MEAT, JULY 1951-June 1953.

Statistical Measure	Explanatory Variable	
	Price of All Meat	Tempera- ture
b	-.0922	-.0646
beta	-.5047	-.6660
σ_{β}	.0863	.0863
t	5.85	7.72

The standard error of estimate was .333 pounds. The mean quantity was 7.59 pounds per family.

Based on the results of equation (6.3), the price elasticity at the mean price and quantity was -.7. A 5 degree rise in the weekly average of mean daily temperatures was associated with a decline of .32 pounds in the quantity of all meats purchased by the average panel family.

CHAPTER X

SUMMARY AND CONCLUSIONS

This study was directed toward the measurement of demand for different kinds and cuts of meats. The principal objective was to measure consumer response to price changes. This was the first study of demand for meats based on continuous food purchase records kept by a representative sample of families.

The source of data for this study was the M.S.C. Consumer Panel. Weekly observations on prices, quantities, total expenditures and percent buying, for several kinds and cuts of meat, were available for the two-year period, July 1951-June 1953. Quantities and expenditures were summarized on the basis of family averages for the entire panel with adjustments for locker purchases, gifts, and game. The various series of prices were computed by dividing total expenditures by total quantities purchased by the entire panel.

Single equation demand models were developed for each of the major meat groups. In each case the weekly average quantity purchased per family of a particular meat group, was expressed as a function of the prices of the different kinds of meat. For example:

Quantity of beef = f (price of beef, price of pork, price of sausage, price of poultry, price of fish)

In some equations a measure of current family income and temperature were also included as "demand shifters." Observations for Thanksgiving, Easter, and Christmas weeks were omitted from the analysis because of the extreme shifts in demand occurring at these times.

The equations were fitted using traditional least squares regression. The mathematical form of the equations was as follows:

$$Y = a + b X_1 + cX_2$$

where Y was quantity and the X's were the prices. When using this type of function, it is implied that the relationships among the variables are constant in arithmetic terms. Therefore, the price elasticities and cross elasticities of demand vary at different points on the demand function.

Due to the time sequence at which the data became available, two sets of analyses were made. The first set was based on weekly purchase data for the July 1951-December 1952 period. The second set of equations used only the data for the July 1952-June 1953 period in order to avoid possible disturbances resulting from beef price controls. The greatest changes in beef and pork prices also occurred during this later period.

The results of the regression analyses indicate that the response to price changes were highly significant statistically, and of approximately the same magnitude for both beef and pork. For the period, July 1952-June 1953, a change of 5 cents per pound in the price of beef was associated with a change in the opposite direction of .222 pounds purchased per family per week. For pork, a change of 5 cents in average price was associated with an opposite change of .221 pounds in the quantity purchased. At the mean values the price elasticities were -.94 and -1.25 for beef and pork, respectively. The price elasticity for selected points on the demand function for beef were as follows:

Price per Pound	Price Elasticity
72 cents	-1.21
63.9 cents (mean)	- .94
56 cents	- .74

In a similar manner price elasticities of demand for pork were estimated for different price levels:

Price per Pound	Price Elasticity
67 cents	-1.55
61.2 cents (mean)	-1.25
55 cents	- .99

In percentage terms, the demand for pork appeared to be more elastic than the demand for beef. However, when allowance is made for cyclical adjustments in prices and supplies, the price elasticities of demand for both beef and pork would be estimated at about unity. The above elasticity estimates are based on equations (1.5) and (2.4) which were discussed in detail in the preceding chapters.

The results of the regression analyses indicated that the price elasticity of demand for sausage meats probably did not differ significantly from zero. The price elasticity of demand for poultry was estimated at -1.43 at the mean level of price. The price elasticity for fish was estimated at -1.87 at the mean. Although statistically significant, the elasticities for poultry and fish are subject to question. In both cases the non-homogeneity of the meat groups and their changing composition over time may have biased the estimates.

The price elasticity of demand for <u>all meat</u> was estimated at -.7 for the period July 1951-June 1953. This appeared to be reasonable as compared to the estimates of price elasticity for the different meat groups.

The regression results indicated that beef and pork were mildly substitutable. However, the effect of beef prices on pork purchases appeared to be greater than the effect of pork prices on beef purchases. A change of 5 cents per pound in the price of pork was associated with a change of .076 pounds, in the same direction, in the quantity of beef purchased per family per week. A change of 5 cents per pound in the price of beef was associated with a change of .120 pounds in the same direction in pork purchases. The cross elasticity of demand for beef with respect to the price of pork was .31 at the means. The cross elasticity of demand for pork with respect to the price of beef was .71. However, the reliability of these cross elasticities might be questioned. The regression coefficients for the price of pork were relatively unstable in the beef equations and none was significant above the 10 percent level. The prices of sausage, poultry, and fish did not appear to have a significant influence on the purchases of either pork or beef.

The results of this study supported the widely held belief that there are seasonal shifts in demand for meats. It was found that a seasonal increase in demand occurred around September 1. Demand declined slightly during Lent and then dropped off significantly during late May and early June. A temperature variable was used as a demand shifter in some of the regression equations. It was found that during the warm season a 10 degree increase in the weekly average of mean daily temperatures would decrease meat purchases per family by the following amounts:

Beef.........	.235 pounts	.... 8 percent
Pork.........	.166 pounds	....7$\frac{1}{4}$ percent
All meat.....	.646 pounds	....8$\frac{1}{2}$ percent

No reasonable estimates of income elasticity were obtained from this series of regression analyses. Part of the difficulty was due to the high intercorrelation of beef quantity and beef prices with current income.

A preliminary analysis of demand for selected retail meat cuts indicated that the price elasticities were approximately as indicated below for the July 1952-June 1953 period:

Ground beef......	inelastic
Bacon	slightly inelastic
Beef roasts	slightly elastic
Pork chops	slightly elastic
Ham	slightly elastic
Beef steak	highly elastic

The various measurements of demand elasticities for meats derived from this study are offered as tentative estimates. It will be possible to obtain more reliable estimates as the M.S.C. Consumer Panel operates over a longer period of time. More refined measurement procedures should be attempted. It appears that the inter-relationships of prices and quantities for different meat groups might lend themselves to some type of simultaneous equation solution. Furthermore, it is believed that analysis of demand for retail cuts of meat should be expanded. This might well include both time series and cross-sectional procedures of analysis.

*
***
*

BIBLIOGRAPHY

Agr. Mkt. Ser., U.S.Dept. of Agr. _The Farm Income Situation_, March, 1954, p.9.

______. _The Marketing and Transportation Situation_, February 1954, p.40.

Anderson, R.H., _Consumer Demand for Meat_, N.Y.(Cornell) Agr. Exp. Sta., Bul. 816, 1945.

Anderson, R.L., "The Problems of Autocorrelation in Regression Analysis," _Jour.Amer.Stat.Assoc._, 49:113-149,1954.

Bercaw, Louise O. "Price Analysis: Selected References on the Theoretical Aspects of Supply and Demand Curves and Related Subjects," _Econometrica_, 2:399-421, 1934.

Bilkey, Warren J. _The Basic Relationships in Consumer Expenditure Behavior_, Harvard Studies in Marketing Farm Products, Number 4-H, Cambridge, 1951, 66pp.

______ "The Vector Hypothesis of Consumer Behavior," _Jour. of Mktg._, 16:137-151, 1951.

Breimeyer, H.F. "Retail Value of Meat Consumption Relative To Consumers' Income as a Measure of Demand for Meat," _Jour.Farm.Econ._, 31:520-24, 1949.

Bur. of Agr. Econ., U.S.Dept. of Agr. _The Livestock and Meat Situation_, September, 1950, p.12

______ _Consumption of Food in the United States, 1909-52_. Agr. Handbook No.62, 1953, 249 pp.

______ _Agricultural Outlook Charts_. 1954.

Bur.of Human Nutrition and Home Econ., U.S.Dept.of Agr., _Meat Selections of City Families_. Commodity Summary No.1, 1949, 9 pp.

______ _Meat: Variations in Consumption and Interrelationships with Other Foods_. Commodity Summary No. II, 1951, 31 pp.

Bur. of Labor Stat., U.S.Dept of Labor. Food Pricing Specification Manual, January, 1954.

Burk, Marguerite C. "Changes in Demand for Food from 1941 to 1950," Jour.Farm.Econ., 33:281-298, 1951.

Cassady, Jr., Ralph. "The Time Element and Demand Analysis," Chap.12, pp.193-207, in Reavis Cox and Wroe Alderson, eds. Theory in Marketing. Richard D. Irwin, Inc., Chicago, 1950.

Clawson, Marion. "Demand Interrelationships for Selected Agricultural Products," Quar.Jour.Econ., 57(2): 265-302, 1943.

Cochrane, D. and G.H.Orcutt. "Application of Least Squares Regression to Relationships Containing Auto-Correlated Error Terms." Jour.Amer.Stat.Assoc., 44:32-61, 1949.

Council of Economic Advisors. The Economic Situation at Mid-year, 1951: a Report to the President, U.S. Gov't. Printing Office, 1951, pp.90, 96.

Cover, J.H. Neighborhood Distribution and Consumption of Meat in Pittsburgh as Related to Other Social and Economic Factors, Univ.of Chicago Press, Chicago, 1932, 226pp.

Dipmann, Carl W., and W.R.Mueller. "21st Annual Progressive Grocer Survey," Progressive Grocer, March 1954, p.46

Ezekiel, Mordecai. Methods of Correlation Analysis. John Wiley, New York. 2d ed., 1941, 531 pp.

______ "A Statistical Examination of Factors Relating to Lamb Prices," Jour.Pol.Econ., 35:233-60, 1927.

Foote, Richard J., and Karl A. Fox. "Analytical Tools for Measuring Demand. Agr.Mkt.Ser., U.S.Dept.of Agr., Agr. Handbook No.64, 1954, 86 pp.

Fox, Karl A. The Analysis of Demand for Farm Products, U.S. Dept. of Agr., Tech. Bul. No.1081, 1953, 90pp.

______ "Factors Affecting Farm Income, Farm Prices, and Food Consumption," Agr.Econ.Res., 3:65-111, 1951.

______ "Relations Between Prices, Consumption and Production" Jour.Amer.Stat.Assoc., 46:323-32, 1951.

French, Burton L. Applications of Simultaneous Equations to the Analysis of the Demand for Meat. Unpublished M.S. thesis, Iowa State College, Ames, 1949, 53.pp.

Friedman, Milton. "The Marshallian Demand Curve," Jour. Pol.Econ., 57:463-495, 1949

Girshick, M.A., and Trygve Haavelmo. "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Equations." Econometrica, 15:79-110, 1947.

Gold, Norman L., and Maxine Enlow. "The Demand for Food by Low Income Families." Quar.Jour.Econ., 57:596-629,1943.

Haas, G.C., and Mordecai Ezekiel. Factors Affecting the Price of Hogs. U.S.Dept. of Agr., Bul.1440, 1926.

Haavelmo, Trygve. "The Statistical Implications of a System of Simultaneous Equations." Econometrica, 11:1-12, 1943.

Hicks, J.R. Value and Capital, 2d ed., Oxford Univ.Press, London, 1946, 340 pp.

Hildreth, Clifford, and Frank Jarrett. "A Statistical Study of Livestock Production and Marketing." Cowles Commission Discussion Paper (Economics No.2055 and Statistics No.375), November 13, 1952.

Judge, George Garrett. An Econometric Analysis of the Demand for Eggs. Unpublished Ph.D. thesis, Iowa State College, Ames, 1952, 230. pp.

Katona, George. Psychological Analysis of Economic Behavior, McGraw-Hill, New York, 1951, 347 pp.

Klein, Lawrence R. Econometrics. Row Peterson and Co., Evanston, Ill., 1953, 355 pp.

Knight, Frank H. "Realism and Relevance in the Theory of Demand." Jour.Pol.Econ., 52:289-318, 1944.

Kuznets, G.M. "Measurement of Market Demand with Particular Reference to Consumer Demand for Food," Jour. Farm Econ., 35:878-895, 1953.

Kuznets, G.M., and Lawrence R. Klein. A Statistical Analysis of the Domestic Demand for Lemons, Giannini Found., Agr. Econ. Rept. 84, 1943, 112pp.

Marshall, Alfred. Principles of Economics, Macmillan, London, 8th ed., 1920, 871 pp.

Meat Merchandising, Inc. Master Meat Pricer, 105 S.9th St., St.Louis 2, Mo., 1949, 87 pp.

Miller, Earl E. "Changes in Demand for Pork Products." The Livestock and Meat Situation. Bur.of Agr.Economics, U.S.Dept. of Agr., May-July, 1953, pp.14-19.

Morgenstern, Oskar. "Demand Theory Reconsidered." Quar.Jour. Econ., 62:154-201, 1948.

Morrissett, Irving. "Some Recent Uses of Elasticity of Sub-Stitution--A Survey." Econometrica, 21:41-62, 1953.

Moss, Thomas N. Some Relationships of Selected Socio-Economic Factors to Food Consumption and Expenditures, Lansing, Spring, 1950, Unpublished Ph.D. thesis, Michigan State College, 1952, 365 pp.

Mosteller, Frederick and Phillip Nogee. "An Experimental Measurement of Utility," Jour.Pol.Econ., 59:371-404, 1951.

National Live Stock and Meat Board, Pricing Retail Meat Cuts, 407 S. Dearborn St.,Chicago, Ill., 23 pp.

Norris, Ruby Turner. The Theory of Consumer's Demand, rev.ed. Yale Univ.Press, New Haven, 1952, 237 pp.

North Central Livestock Marketing Research Committee. Meat Retailing in the North Central States, preliminary bulletin manuscript.

Prest, A.R. "Some Experiments in Demand Analysis." Review of Econ. Statistics, 31:33-49, 1949.

Purcell, J.C., and V.John Brensike. Net Marketing and Slaughter of Livestock and Consumption by Regions, 1950. Preliminary Report, Bur. of Agr. Econ., U.S.Dept.of Agr.,

Quackenbush, Gerald G. "Demand Analysis from the M.S.C. Consumer Panel." Journal Article No.1594, Mich.Agr.Exp. Sta. A paper delivered at the joint meeting of the Amer. Stat. Assoc. and the Amer.Farm Econ.Assoc., Washington, D.C. December 30, 1953.

Quackenbush, Gerald G., and J.D. Shaffer. Consumer Purchases of Ice Cream for Home Use. Unpublished manuscript, Dept. of Agr. Econ., Michigan State College.

Rousseas, Stephen W., and A.G. Hart. "Experimental Verification of a Composite Indifference Map." Jour.Pol. Econ., 59:288-318, 1951.

Sartorius, Lester C., and Marguerite Burk. Eating Places as Marketers of Food Products, Bur.of Agr. Econ., U.S.Dept. of Agr., in cooperation with the Univ.of Minn., Marketing Research Report No.5, 1952, 118 pp.

Schrader, F.M. The Demand for Meat in Canada. Economics Division, Canada Dept. of Agr., Ottawa, July, 1953, 10 pp.

Schultz, Henry. "The Statistical Measurement of Elasticity of Demand for Beef." Jour.Farm Econ., 6:254-278,1924.

——— The Theory and Measurement of Demand, Univ. of Chicago Press, Chicago, 1938, 817 pp.

Shaffer, J.D., G.G.Quackenbush and T.H.Moss. The Consumption of Meat and Related Products in Lansing, Michigan, Spring, 1950. Mich.Agr.Exp.Sta., Tech.Bul.239, 1954, 25 pp.

Shaffer, J.D. Methodological Bases for the Operation of a Consumer Purchase Panel. Unpublished Ph.D. thesis, Michigan State College, 1952, 707 pp.

——— "A Plan for Sampling A Changing Population Over Time." Jour.Farm Econ., 36:153-163, 1954.

Shepherd, Geoffrey. Changes in the Demand for Meat and Dairy Products in the United States since 1910. Iowa Agr.Exp. Sta. Bul. 36[illegible], 1949, 3[illegible] pp.

——— "The Incidence of the Processing Tax on Hogs." Jour. Farm Econ., 17:321-338, 1935

Simmons, Will M. Consumer Meat Purchases in Syracuse, N.Y. 1948 and Comparison with 1942, N.Y. (Cornell) Agr. Exp. Sta. Bul. [illegible], 1951, 30 pp.

Sims, Grover J., and Lucille Johnson. "Geography of Meat Animal Production and Meat Consumption." The Livestock and Meat Situation. Bur.of Agr.Econ., U.S. Dept. of Agr., August, 1948, pp.17-23.

Smith, Harold D., Consumer Demand for Chicken as Related to Demand for Total Meat. Dept. of Agr. Econ. and Mktg., University of Maryland, Miscellaneous Publication No. 112, 1951, 36 pp.

Smith R.C. Factors Affecting Consumer Purchases of Frying Chickens, Delaware Agr. Exp. Sta. Tech. Bul. 290, 1953, 33 pp.

Smith, Victor E. "The Classicists' Use of Demand." Jour. Pol. Econ., 59:242-257, 1951.

Snedecor, George W. Statistical Methods. 4th ed., Iowa State College Press, Ames, Iowa, 1946, 485 pp.

Staehle, Hans. "Relative Prices and Postwar Markets for Animal Food Products." Quar. Jour. Econ., 59:237-79, 1945

Stigler, George J. The Theory of Price, rev. ed., Macmillan, New York, 1952, 310 pp.

Szatrowski, Zenon. "Time Series Correlated with the Beef-Pork Consumption Ratio." Econometrica, 13:60-78, 1945.

Thomsen, F.L., and R.J. Foote. Agricultural Price, 2d. ed., McGraw-Hill, New York, 1952, 509 pp.

Tintner, Gerhard. Econometrics. John Wiley, New York, 1952, 370 pp.

U.S. Bur. of Census. "Characteristics of the Population." 1950 Census of Population. Vol. II

U.S. Dept. of Agr. Family Food Consumption in the United States, 1942, Miscellaneous Publication No. 550, 1944.

Wahby, Omar. Econometric Analysis of the Demands for Beef, Pork, and Poultry Products. Unpublished Ph.D. thesis, Iowa State College, 1951.

Waite, W.C., and R.W. Cox. A Study of the Consumption of Meats in Minneapolis, 1934. Minnesota Agr. Exp. Sta. Bul. 321, 1935, 26 pp.

Waite, W.C. and H.C. Trelogan. Agricultural Market Prices. 2d ed., John Wiley, New York, 1951. 440 pp.

Walsh, R.M. "Statistical Techniques for the Analysis and Interpretation of Price Data." Pricing and Trade, a report of the National Marketing Workshop, 1952, pp. 107-120.

Waugh, F.V., "Applicability of Recent Developments in Methodology to Agricultural Economics." Jour. Farm Econ., 35:692-706, 1953.

——— Readings on Agricultural Marketing. Iowa State College Press, Ames, Iowa, 1954, 456 pp.

Wicksell, Knut. Lectures on Political Economy, Routledge and Kegan Paul, Ltd., London, 1934, 299 pp.

Wold, Herman, and Lars Jureen. Demand Analysis, John Wiley, New York, 1953, 358 pp.

Woodlam, A.E. The Influence of Prices on the Relative Consumption of Beef and Pork, Economics Division, Canada Dept. of Agr., 1953, 9 pp.

Working, Elmer J. "Agricultural Demand During Rearmament." Jour. Farm Econ., 34:206-224, 1952.

——— Studies in the Measurement of Demand with Special Reference to the Demand for Meat. Unpublished Ph.D. thesis, Harvard, 1952.

APPENDIX

MICHIGAN STATE COLLEGE

WEEKLY CONSUMER FOOD PURCHASE DIARY

This diary is for recording all food purchases for the week of

Sunday............................ through Saturday.........................

1. May we emphasize that each of your diaries is important to us, whether your food purchases are many or few. Your diaries will be of most value if made out accurately and returned promptly — every week.

2. We suggest that you enter food items in the diary each day as you make the purchase.

3. If a food item that you use is home-grown or a gift, show this by writing "home-grown" or "gift" in the price column.

4. If you don't know under which heading to enter a food item, you can list it in one of the blank spaces on page 15.

5. At the end of the week check through the diary to make sure you haven't forgotten any purchase or made any incomplete entries.

6. As you are checking the diary also √ the squares (☐ None) if appropriate.

7. If you want any information, call us at the college—number 8-1511, extension 7364.

INDEX

WHAT YOU CAN EARN BY KEEPING THE DIARY

If you return the diary for 52 weeks or more without missing a week, you earn **40 points** for each diary returned in the sequence.

or

If you return the diary for 12 to 51 weeks without missing a week, you earn **35 points** for each diary returned in the sequence.

or

If you return the dairy for 5 to 11 weeks without missing a week, you earn **25 points** for each diary returned in the sequence.

or

If you return the diary less than five weeks in a row, you earn **10 points** for each diary.

PLUS

1. A bonus of **5 points** for each diary returned on time (postmarked before Tuesday noon of the following week).
2. A bonus of **70 points** if you return every diary on time for a year.
3. A bonus of **10 points** for each diary returned during July and August.
4. A bonus of **5 points** for each diary returned after returning 52 diaries.

You can earn 2500 points the first year and 2760 points for each additional year.

(2)

DAIRY PRODUCTS

MILK

NONE ☐

FRESH	1100	Number of Quarts	Price per Quart	Total Amt. Paid	51 Where Purchased*	52 Brand
Homogenized—Vit. D.	1110				See note below	
Homogenized—Plain	1120					
Regular Pasteurized	1130					
Jersey or Guernsey	1140					
Buttermilk	1150					
Chocolate	1160					
Skim	1170					
Sour Milk, Yoghurt, etc.	1180					
Egg nog, etc.	1181					
Other Milk	1190					

CANNED	1200	Number of Cans	Size of Can Indicate Ozs.	Price per Can	Total Amt. Paid	Brand
Evaporated—Unsweetened	1210					
Condensed—Sweetened	1220					

DRIED	1300	Number of Pounds	Price per Pound	Total Amt. Paid		Brand
Powdered—Skim Milk	1310					
Powdered—Whole Milk	1320					
Powdered—Baby Formulas	1330					
Ice Cream Mix	1340					
Malted Milk Powder	1321					

CREAM NONE ☐	1400	Number of ½ Pints	Price per ½ Pint	Total Amt. Paid	Where Purchased*	Brand
Coffee Cream	1410				See note below	
Whipping Cream—bottle	1421					
Whipping Cream—can	1422					
Sour Cream	1430					

*For Fresh Milk and Cream—Please indicate from whom it was bought in the fourth column as follows:

1. If delivered by milkman
2. If bought from grocery store
3. If bought from cash and carry specialized dairy store
4. If bought from other source

DAIRY PRODUCTS (cont.)

ICE CREAM NONE ☐	1500	Number of Pints	Price per Pint	Total Amt. Paid	51 Where Purchased	52-53 Brand
Hand Packed	1510					
Pre-Packaged	1520					
Other	1530					

CHEESE NONE ☐		Number of Lbs., Ozs.	Price per Pound	Total Amount Paid	Check one: Bulk	Jar	51 Pre-Pkgd.
Natural American Cheese	1610						
Processed American Cheese	1710						
Cheese Spread	1720						
Other Cured Cheese	1620						
Cream Cheese	1810						
Cottage Cheese	1820						

FATS AND OILS

FATS NONE ☐	2100	Number of Pounds	Price per Pound	Total Amt. Paid
Butter	2110			
Oleomargarine	2120			
Lard	2130			
Vegetable Shortening	2140			
Other Fats (name kind)	2150			

OILS NONE ☐	2200	Number of Pints or Ozs.	Price per Unit	Total Amt. Paid
Cooking Oils	2210			
Mayonnaise	2220			
Salad Dressing	2221			
Salad Oils, French Dressing, etc.	2230			
Other Oils	2240			
Tartar Sauce	2241			
Sandwich Spreads	2242			
Whips and Toppings	2250			

The extra spaces are for additional purchases of listed items and for items not listed. If there aren't enough extra spaces on the classified pages, turn to the last page.

FRUITS

		Number of Units	Size of Unit	Price per Unit	Total Amt. Paid	1 Fresh	2 Frozen	3 Canned	4 Dried	5 Jam, Jelly, etc.
BERRIES NONE ☐	3100									
Blueberries	3110									
Cranberries	3120									
Currants	3121									
Dewberries	3130									
Raspberries	3140									
Strawberries	3150									
Other Berries (name kind)	3160									
CITRUS NONE ☐	3200									
Grapefruit	3210									
Grapefruit Juice	3219									
Lemons	3220									
Lemon Juice	3229									
Limes	3230									
Oranges	3240									
Orange Juice	3249									
Tangerines	3250									
Other Citrus (name kind)	3260									
Other Citrus Juice (name kind)	32-9									
Mixed Citrus Fruit	3290									
Mixed Citrus Juices	3299									
OTHER FRUITS NONE ☐	33-35									
Apples	3310									
Applesauce and Applebutter	3311									
Apple Cider	3318									
Apple Juice	3319									
Apricots	3320									
Apricot Juice	3329									

Please don't forget to enter home grown, home canned, and gift items.

FRUITS (cont.)

OTHER FRUITS Cont.		Number of Units	Size of Unit	Price per Unit	Total Amt. Paid	Fresh 1	Frozen 2	Canned 3	Dried 4	Jam, Jelly, etc. 5
Avocados	3330									
Bananas	3340									
Cherries—Sour	3351									
Cherries—Sweet and Maraschino	3352									
Dates	3360									
Figs	3370									
Fig Juice	3379									
Grapes	3380									
Grape Juice	3389									
MELONS	3410									
Cantalope	3411									
Watermelon	3412									
Other Melon (name kind)	3410									
Nectarines	3420									
Olives	3435									
Persimmons	3430									
Peaches	3440									
Pears	3450									
Pineapple	3460									
Pineapple Juice	3469									
Plums	3470									
Prunes	3480									
Prune Juice	3489									
Raisins	3510									
Rhubarb	3520									
All Other Fruit (name kind)	3530									
All Other Fruit Juice (kind)	35-9									
Mixed Fruits (except citrus)	3590									
Fruit Cocktail	3590									

In reporting Fruits and Vegetables please indicate, where possible, the actual quantity purchased in weight or liquid measure.

VEGETABLES

GREEN LEAFY VEGETABLES NONE ☐	41-43	Number of Units	Size of Unit	Price per Unit	Total Amt. Paid	1 Fresh	2 Frozen	3 Canned	4 Dried	5 Soup
Brussel Sprouts	4110									
Cabbage	4120									
Sauerkraut, Cabbage Salad, etc.	4121									
Celery	4130									
Celery Cabbage	4140									
Endive, Chicory, Escarole	4160									
Lettuce—Head	4210									
Lettuce—Leaf	4220									
Mustard	4240									
Parsley, Swiss Chard, Water Cress	4250									
Spinach	4260									
Mixed Leafy Vegetables	4290									
Other Leafy Vegetables	4300									

GREEN AND YELLOW VEGETABLES NONE ☐	44-45	Number of Units	Size of Unit	Price per Unit	Total Amt. Paid	Fresh	Frozen	Canned	Dried	Soup
Artichokes	4410									
Asparagus	4420									
Beans—Lima	4430									
Beans—Snap	4440									
Beans—Sprout	4450									
Broccoli	4460									
Carrots	4470									
Corn—Sweet	4480									
Peas	4530									
Peppers	4540									
Pumpkin	4550									
Squash	4560									
Sweet Potatoes and Yams	4570									
Mixed Green and Yellow Vegetables	4590									
Other										

Be sure to fill in the "size of unit column," and at least two of the other three columns, as well as check the method of preservation.

VEGETABLES (cont.)

ALL OTHER VEGETABLES NONE ☐	47-49	Number of Units	Size of Unit	Price per Unit	Total Amt. Paid	1 Fresh	2 Frozen	3 Canned	4 Dried	5 Soup
Beans—Navy, Baked, White	4701									
Beans—Kidney	4703									
Beets	4710									
Cauliflower	4720									
Cucumbers	4731									
Pickles and Relish	4732									
Egg Plant	4740									
Garlic	4750									
Mushrooms	4780									
Onions—Mature	4811									
Onions—Green	4812									
Oyster Plant (Salsify)	4820									
Parsnips	4830									
POTATOES	4840									
Michigan Potatoes	4841									
Maine Potatoes	4842									
Idaho Potatoes	4843									
California Potatoes	4844									
Other state grown Potatoes	4845									
Potatoes (Don't know state)	4846									
Potato Chips and Sticks	4847									
Potato Salad	4848									
Radishes	4850									
Tomatoes	4871									
Tomato Catsup and Sauces	4872									
Tomato Juice	4873									
Turnips and Rutabagas	4880									
Other Vagetables (name kind)	4900									
Mixed Vegetables	4990									
Chop Suey, Chow Mein, etc.	4990									
Mixed Vegetable Juice	4999									
Vegetable Soup	4991									
Vegetable and Meat Soup	4992									

Please don't forget to enter home grown, home canned, and gift items.

MEAT

BEEF NONE ☐	5100	Number of Lbs., Ozs.	Price per Pound	Total Amt. Paid	Check If: Boned	Frozen	Pre-Pkgd.
Canned Beef	5110						
Corned or Chipped Beef	5120						
Ground Beef, Hamburger	5130						
Liver	5141						
Heart, Tongue, other Organ Parts	5142						
Roast	5160						
Steak	5170						
Stewing, Boiling, Soup	5180						
All Other Beef (name kind)	5190						

PORK NONE ☐	5300	Number of Lbs., Ozs.	Price per Pound	Total Amt. Paid	Check If: Boned	Frozen	Pre-Pkgd.
Bacon	5311						
Canadian Bacon	5312						
Canned Pork	5320						
Chops	5330						
Steaks	5335						
Ham	5341						
Picnic Ham—Shoulder—Butts	5342						
Liver	5351						
Heart, Tongue, other Organ parts	5352						
Roast	5370						
Sausage	5381						
Spareribs	5382						
Other Pork	5390						
Side or Salt Pork	5391						

MEAT (cont.)

LAMB-MUTTON	NONE ☐	5200	Number of Lbs., Ozs.	Price per Pound	Total Amt. Paid	Check if: Boned	Frozen	Pre-Pkgd.
Canned		5210						
Chops-Steaks		5220						
Ground or Grinding		5230						
Heart, Liver, Other Organ Parts		5240						
Roast (Leg, etc.)		5260						
Stewing, Soup, etc.		5270						
Other Lamb-Mutton (kind)		5280						

VEAL	NONE ☐	5400	Number of Lbs., Ozs.	Price per Pound	Total Amt. Paid	Boned	Frozen	Pre-Pkgd.
Canned Veal		5410						
Cutlets, Chops		5420						
Ground Veal		5430						
Liver		5441						
Heart, Tongue, Other Organ Parts		5442						
Roast		5460						
Stewing, Soup Veal		5470						
Veal Loaf		5480						
Other Veal (name kind)		5490						

OTHER MEAT	NONE ☐	5500	Number of Lbs., Ozs.	Price per Pound	Total Amt. Paid
Wieners and Franks, etc.		5510			
Bologna, Salami, etc.		5520			
Cold Cuts		5530			
Rabbit and Other Game		5540			
Other Meat (name kind)		5550			
Prem, Spam, Treet, etc.		5551			
Chop Suey Meat		5552			

Be sure to ☒ if meat is frozen, boned or pre-packaged. Other meats, poultry, eggs, fish and other sea food are on page 10.

Do not include sales tax in reporting price or total amount paid.

Report prepared baby food on page 11.

MEATS, POULTRY, FISH, EGGS

MIXTURES — CHIEFLY MEAT NONE ☐	5590	Number of Lbs. and/or Ozs.	Price per Pound	Total Amt. Paid
Chili Con Carne	5591			
Hash	5592			
Soup	5593			
Mincemeat	5594			

					51 Check One					52 Check One		
POULTRY NONE ☐	5600	Number of Lbs., Ozs.	Price per Pound	Total Amount Paid	1 Alive	2 Dressed	3 Ready to Cook	4 Boned	5 Selected Parts	1 Fresh	2 Frozen	3 Canned
CHICKEN	5610											
Broilers or Fryers	5611											
Roasters	5612											
Stewing	5613											
TURKEY	5620											
DUCK	5630											
OTHER POULTRY (kind)	5640											
MIXTURES—CHIEFLY CHICKEN	5690											
Chicken Noodle Dinner	5691											
Chicken a la King	5692											
Soup	5693											
Chicken Chop Suey, etc.	5694											

EGGS NONE ☐	5700	Number of Dozen	Price per Dozen	Total Amount Paid	51 Size	52 Grade	Check if Ungraded

					51 Check One				52 Check One		
FISH AND SEA FOOD NONE ☐	5800	Number of Pounds and/or Ozs.	Price per Pound	Total Amount Paid	1 Dipped in Batter	2 Shelled	3 Cleaned	4 Other	1 Fresh	2 Frozen	3 Canned
Tuna	5811										
Salmon	5812										
Other Fish	5813										
Oysters	5820										
Scallops	5830										
Shrimp	5840										
Other (name kind)	5850										
MIXTURES — CHIEFLY FISH	5890										

PREPARED BABY FOOD

FRUITS		Number of Units	Size of Unit	Price per Unit	Total Amt. Paid	51 Code
Applesauce	3311					9
Apricots	3320					9
Bananas	3340					9
Orange Juice	3249					9
Peaches	3440					9
Pears	3450					9
Plums	3470					9
Prunes	3480					9
Other Fruits	3530					9
						9
Mixed Fruits	3590					9
						9
Puddings	7420					9
						9
VEGETABLES						9
Beets	4710					9
Carrots	4470					9
Green Beans	4440					9
Peas	4530					9
Spinach	4260					9
Squash	4560					9
Sweet Potatoes	4570					9
Other Vegetables	4900					9
						9
Mixed Vegetables	4990					9
						9
MIXED VEGETABLES AND MEAT	4992					9
						9
						9
						9
MEATS, CHICKEN AND FISH						9
Beef	5150					9
Chicken	5610					9
Lamb	5250					9
Liver	5141					9
Pork	5360					9
Tuna	5811					9
Veal	5450					9
Other	5500					9

(12)

BAKED GOODS AND OTHER GRAIN PRODUCTS

BREAD NONE ☐ 6100	Number of Loaves	Price per Loaf	Total Amt. Paid	Kind of Bread 1 White	2 Whole Wheat	3 Rye	4 Other

	Amount	Total Amount Paid
QUICK BREADS AND ROLLS 6200		
CAKES 6310		
COOKIES 6320		
DOUGHNUTS 6330		
PIES (name kind) 6400		
PREPARED BAKED GOODS MIXES 6500		
Cake Mix 6510		
Cookie Mix 6520		
Quick Bread Mix 6530		
Pancake Mix 6540		
Pie Crust Mix 6550		
Whole Pie Mix 6560		
Other (name kind) 6570		

Where convenient TOTAL Amount Paid may be reported as price X quantity. That is, if you buy 3 doz. cookies at 35¢ per doz. you may report it in the total amount paid column as 3 doz. X 35¢.

PLEASE Check Type of Grain Below ↓

Check ONE

NONE ☐	Number Lbs. and/or Ozs.	Price per Pound	Total Amt. Paid	1 Barley	2 Buck-wheat	3 Corn	4 Oats	5 Rye	6 Rice	7 Wheat
OTHER GRAIN PRODUCTS 6600										
Breakfast Cereals										
All Other (name kind)										
(Includes crackers, meal, popcorn,										
spaghetti, pretzels, noodles, etc.)										

Be sure to record your purchases on the same day they are made so that you don't forget any of them. Check the package for weight, etc. Be sure to record the proper price. Use the extra spaces for additional purchases. Please don't forget to fill in the Vital Data Questions on page 15.

SUGAR, SWEETS, CANDY

SUGAR	NONE ☐	7100	Number of Pounds	Price per Pound	Total Amt. Paid
White or Powdered		7100			
Brown		7120			
Maple		7130			
SYRUP AND HONEY	NONE ☐	7200	Number of Pounds and Ozs. or Pts.	Price per Unit	Total Amt. Paid
Corn Syrup		7210			
Cane Syrup		7220			
Maple Syrup		7230			
Molasses		7240			
Sorghum		7250			
Other Syrup		7260			
Honey		7270			
CANDY	NONE ☐	7300	Number of Pounds and Ounces	Price per Pound	Total Amt. Paid
PREPARED DESSERT MIXES	NONE ☐	7400			
Gelatin, Jello, etc.		7410			
Pudding		7420			
Other Mix (name kind)		7440			
ALL OTHER SWEETS	NONE ☐	7450			

NUTS AND NUT PRODUCTS

NONE ☐	7500	Number of Lbs., Ozs.	Price per Pound	Total Amt. Paid	Check One: In Shell	Shelled	Canned
Coconuts	7530						
Peanuts	7541						
Peanut Butter	7542						
Other Nuts (name kind)	7570						

Have you included all of the food purchases by other members of the household?
Do not include sales tax in reporting price or total amount paid.

BEVERAGES

NONE ☐	8100	Number of Units	Size of Unit Specify Ozs., Lbs., etc.	Price per Unit	Total Amount Paid
Beer	8110				
Liquors	8120				
Wine	8130				
Cocoa	8210				
Coffee	8220				
Tea	8230				
Soft Drinks—bottled	8310				
Soft Drinks—powdered	8320				

NONE ☐ VITAMINS AND MINERALS

VITAMINS (name kind)	8400	Quantity Purchased	Total Amount Paid
MINERALS (name kind)	8500		

COOKING AIDS

NONE ☐	8900	Number of Units	Size of Unit	Price per Unit	Total Amount Paid
Baking Powder	8911				
Baking Soda	8912				
Canning Aids (Certo, etc.)	8969				
Chocolate—Baking	8921				
Extracts (name kind)	8930				
Meat Sauces (name kind)	8940				
Salt	8950				
Spices (name kind)	8960				
Pepper	8961				
Vinegar	8971				
Yeast	8972				

EXTRA SPACE (for items not listed in diary) (15)

Description	Number of Units	Size of Unit	Price per Unit	Total Amount Paid

VITAL DATA QUESTIONS

1. Has there been any change in your household membership since your last reporting week? YES NO (circle one)
   If yes, what was their: Relationship to homemaker ______ Age ______
   ______ ______
   How many are there in your household now?______
2. How many regular meals were eaten away from home by members of your household last week?______ (One meal consists of either breakfast, dinner or supper for ONE person). Total amount spent______
3. How many guest meals were served during the past week?______
   (A guest is anyone not a regular household member).
4. What was the total income payment actually received during the diary week by:
   The male and female head of the household?______
   Other members of the household?______
   Check if none______.
5. Was this before or after Federal Income Tax deductions? Before ( ) After ( )
   (In reporting income payments, please keep in mind that they might come from many sources. These include wages, salaries, commissions, pensions, interest and dividends, annuities, profit from business and professional services, profit from rent, government payments, gifts, and any other sources.

This information will be held strictly **confidential,** and your name will not be associated with it. It is necessary to ask these questions in order to get the greatest value from your diary.

Professor G. G. Quackenbush
M. S. C. Consumer Panel
Michigan State College
East Lansing, Michigan

(Paste Gummed Flap Here)

NO POSTAGE STAMP NECESSARY

POSTAGE HAS BEEN PREPAID BY

Professor Gerald Quackenbush
M. S. C. Consumer Panel
Michigan State College
East Lansing, Michigan