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Factors affecting consumer demand for meat, Webster County, Iowa

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FACTORS AFFECTING CONSUMER DEMAND FOR MEAT, WEBSTER COUNTY, IOWA

by

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INTRODUCTION

In recent years livestock producers and meat packers have expressed considerable interest in the merchandising of meat animals. Livestock prices were recognized as being dependent upon consumer tastes, preferences, and buying power, as well as upon the supply of livestock and meat. Post war marketing developments suggested the economic well-being of the livestock producer was as much determined by general economic conditions and trends in social transformation as by the events that transpire wholly within the boundaries of his farm, his county or his state.

This thesis is a part of several research undertakings conducted at Iowa State University pertaining to consumer marketing of meats. It concerns in particular the meat purchasing patterns of households in a prototype consumer market, that of Webster County, Iowa in 1963.

Objectives

The orientation of this thesis can be expressed by the objectives: (a) to determine factors which influence consumer demand for meat products and (b) to measure quantitatively the effects on consumer demand of these factors. The factors of concern can be separated into two classes. One is the socio-economic differences among households which can be associated

with differences in meat consumption patterns. The other is the influences on demand of the various marketing activities undertaken by the retailer in the normal course of business. Upon viewing the household as the center of decision-making leading to consumption, the factors of interest may be dichotomized into those internal and external to the decision-maker.

The objective was to give as much attention to individual meat cuts as possible. Particular emphasis was on variables subject to some degree of control by the meat products industry.

No particular hypotheses were formulated initially. However, several arose at different points in the analysis. Such hypotheses were developed and examined within the text.

REVIEW OF LITERATURE—

Demand Theory

People purchase goods and services to fulfill wants. In analyzing the decision process leading to such purchases, economists often base their analysis upon Paretoan theory.

A consumer is assumed to have available a set of options consisting of combinations of goods and services. Calling a single option a budget, it may be represented as

$$q = (q_1, q_2, \ldots, q_n) \ , \quad q_m \geq 0, \qquad (1)$$

where q_m, m=1,...,n, refers to the quantity of the m^{th} good within the budget. The set of budgets may be called Ω.

Three axioms form the basis for the subsequent theory (50, p. 82):

> Axiom of comparison. The consumer has a definite order of preferences in the following sense. Letting $q^{(1)}$ and $q^{(2)}$ be two arbitrary budget alternatives, three cases are possible: $q^{(1)}$ is preferred to $q^{(2)}$, or $q^{(2)}$ is preferred to $q^{(1)}$, or $q^{(1)}$ and $q^{(2)}$ are equivalent (= indifferent).
>
> Axiom of transitivity. The order of preferences is logically consistent in the following sense: If $q^{(1)}$ is equivalent (preferred, disfavored) to $q^{(2)}$, and $q^{(2)}$ equivalent (preferred, disfavored) to $q^{(3)}$, then $q^{(1)}$ is equivalent (preferred, disfavored) to $q^{(3)}$.
>
> Axiom of choice. The consumer chooses a budget which is preferred to any other budget that he can obtain, provided such a budget exists.

In order to use the ordinary tools of mathematical analysis to summarize the decision-making process, a single-valued

function is defined upon the set Ω. Calling this function U, it is assumed that the following correspondences hold:

a) $q^{(1)}$ preferred to $q^{(2)}$ implies $U(q^{(1)}) > U(q^{(2)})$

b) $q^{(2)}$ preferred to $q^{(1)}$ implies $U(q^{(2)}) > U(q^{(1)})$

c) $q^{(1)}$ equivalent to $q^{(2)}$ implies $U(q^{(1)}) = U(q^{(2)})$

The loci defined by

$$C = U(q) \ , \qquad (2)$$

for which C is the definitional parameter, are called indifference surfaces. Assuming non-satiety, that is, a larger quantity of a commodity is always preferred to a smaller quantity, it becomes apparent that through every point of the budget set Ω there passes one, and only one, indifference surface. An assumption of continuity on the part of budget components, q_m, insures that the indifference surfaces will not take the form of surface fragments. Thus, U must be a well defined function that is continuous and increasing in each variable q_m. For convenience it is also assumed that U has continuous derivatives of first and second order.

It may be noted that if U meets the above requirements as an index of preference for describing the consumer ordinal preference field, any monotonic increasing transformation of U can also be used. U is therefore called an ordinal utility index.

Following the traditional theory of consumer behavior, it is assumed that the consumer is confronted with a set of prices which he cannot affect appreciably. These prices are called p_m and may be written as the vector

$$p = (p_1, p_2, \ldots, p_n). \tag{3}$$

When making purchases within an increment of time, the consumer is assumed to be restrained by fixed resources or say, income. Using I to denote income, its value can be written in terms of prices and quantities

$$\sum_{m=1}^{n} p_m q_m = I. \tag{4}$$

A theory of consumer decision-making can be formed on the above basis upon adding the fundamental assumption that the consumer selects the budget which is highest on his preference scale when confronted by a fixed set of prices and a restraint on total expenditures. Under the assumption that the preferred budget does indeed exist, the decision problem corresponds to finding a constrained maximum for U.

Using the technique of Lagrangean multipliers, the expression to be maximized with respect to q, the decision variable, is

$$W = U(q) + \lambda(I - p'q). \tag{5}$$

Taking partial derivatives of W with respect to q_m, $m=1,2,\ldots,n$ and λ and setting these to zero gives the equa-

tions

$$\frac{\partial U}{\partial q_m} - \lambda p_m = 0, \qquad m=1,2,\ldots,n$$

and

$$I - p'q = 0. \tag{6}$$

These n+1 equations containing n+1 unknowns, q_m, m=1,2,...,n and λ, are dependent upon the parameters p and I.

One result is that the consumer must select a budget such that

$$\frac{\frac{\partial U}{\partial q_m}}{\frac{\partial U}{\partial q_i}} = \frac{p_m}{p_i} \quad , \tag{7}$$

if his preference scale is to be maximized. That is, the consumer selects a budget such that the ratio of the marginal utilities of goods m and i is equal to the ratio of their prices.

The n+1 equations in 6 can, at least conceptually, be solved for the n unknowns q_m. Such equations are traditionally called demand equations. These may be written

$$q_m = D_m(p,I) \quad , \quad m=1,2,\ldots,n \; . \tag{8}$$

Such equations can easily be shown to be homogeneous of degree zero with respect to p and I. This corresponds to the consumer making no change in budget preference when all prices and income are increased by the same proportion.

If the solution q to 6 is indeed a constrained maximum position, it can be shown that (37)

$$\left.\frac{\partial q_m}{\partial p_m}\right|_{U=C} < 0 \quad . \tag{9}$$

Thus, the theory suggests that the consumer whose preference field agrees with the axiomatic bases and whc does choose a preferred budget, will purchase more of commodity m as the price drops. Here, the income of the consumer is assumed to be adjusted so that he remains on the same indifference surface. The assumptions used to reach the calculus solution used herein are not necessary for reaching the above conclusion (36, p. 109).

It has been assumed that the commodities are well defined and distinct when developing the above theory. But theory is only a simplifying abstraction used to portray real world situations. With regard to meat products, for example, the consumer is confronted with an offer of center-cut pork chops at one store for $.55 and end-cut pork chops for $.49 at another. A store ten blocks further away offers center-cut chops for $.59 and end-cuts at $.49. And, a fourth store offers trading stamps as an additional incentive.

One may simply expand the dimension, n, of the q and p vectors to take into account all of the various degrees of product differentiation associated with store location,

quality aspects, and offer variation. However, the degree of product differentiation for many real world products, such as meat in particular, is nearly limitless. Thus, one is confronted with the use of q_m and p_m as index type variables pertaining to a group of goods.

Hicks (22, p. 312) suggests that an important criterion to consider in forming such aggregations is whether price fluctuates nearly proportionally for all individual variants in the aggregate. If prices do move proportionally, he shows that "the group of goods behaves just as if it were a single commodity."

However, when the utility index is written in terms of groups of commodities one may ask whether the index of price paid by the consumer is determined by the consumer or pre-determined by the market? For example, beef chuck roasts constitute a somewhat natural aggregate product class for the current study. But within a single retail store the price for chuck roasts often has a range of $0.40 per pound between the lowest quality roasts and the highest quality boneless cuts. A consumer when restrained by a low income may purchase, say five pounds of chuck roast at a mean price of $0.50. And, when his income is raised, he may still purchase only five pounds, but now he buys a higher quality cut and pays $0.70. Later analysis herein uncovers a decision-making pattern having some similarities to this.

Attention will now be turned to altering the conceptual framework just developed to enable one to use the indexes of prices paid by the consumer as indexes of quality for commodity aggregates. A framework developed by Theil (39) forms much of the basis.

The mean price paid by the consumer for goods in aggregate group m is defined to be $r_m p_m$. The index r_m measures the quality level of the goods selected within the m^{th} group; it is a decision variable for the consumer. The index p_m is a proportionality constant corresponding to the general price level set by the retailer for the m^{th} group. It is a datum to the consumer and a decision variable of the retail market.

The preference field of the consumer when defined in terms of groups of commodities is assumed to take into account quality as well as quantity. Assuming an ordinal utility index to exist which corresponds to the consumer preference field, it can be written

$$U = U(q_1, q_2, \ldots, q_n, r_1, r_2, \ldots, r_n). \tag{10}$$

Maximizing U subject to the restraint

$$\sum_{m=1}^{n} p_m r_m q_m = I \tag{11}$$

provides the marginal conditions

$$\frac{\partial U}{\partial q_m} - \lambda p_m r_m = 0$$

and

$$\frac{\partial U}{\partial r_m} - \lambda p_m q_m = 0 \qquad (12)$$

where λ is a Lagrangean multiplier. These 2n equations plus the restraining equation can be solved, at least conceptually, for the 2n decision variables. This solution produces what may be called quantity and quality demand equations and they can be written as

$$q_m = D_m(p,I) \qquad (13)$$

and

$$r_m = R_m(p,I), \quad m=1,2,\ldots,n \; . \qquad (14)$$

A result similar to 9 can be derived from second order conditions (40, p. 135)

$$\left.\frac{\partial (r_m q_m)}{\partial p_m}\right|_{U=C} < 0 \; . \qquad (15)$$

That is, a drop in retail price for a commodity group suggests an increase in what may be called an index of value of purchases. Again a compensating adjustment is assumed for income so as to keep the consumer on the same indifference surface.

Similar relationships between r_m and p_m and between q_m and p_m cannot be established. Rather, a compensated drop in p_m can only be shown not to lead to a drop in both q_m and r_m. An increase must occur in either q_m or r_m or possibly both q_m and r_m.

When using 13 and 14 as quantity and quality demand equations, the bases of the indexes r_m and p_m can be taken as corresponding to the actual level of prices set by the retail market. The result in 15 suggests that a third type of demand equation be constructed, that of value demanded. Defining value purchased as $v_m = r_m q_m$, use of 13 and 14 gives

$$v_m = V_m(p,I), \quad m=1,2,\ldots,n \ . \tag{16}$$

Generalizing Demand

Investigators suggest that many factors in addition to price and income influence a consumer's decision-making process when making a purchase. Among these factors are advertising, methods of display, packaging, store layout, pleasantness of sales personnel, and selling procedures. One method available for handling product differentiation resulting from such factors is simply to expand the product classification. However, the alternative of inserting an additional variable, say vector a, to account for what may be called "non-price offer variation" (23, p. 102) is used herein.

Up to this point, discussion has centered upon the demand characteristics of an idealized individual. An assumption which is basic to this study as well as to nearly all studies of human behavior, is that the actions of people are subject to classification and measurement. That is, it is assumed that

a demand function can be formulated which will approximate the decision-making activity of non-identical individuals.

Such a demand function must of course be a function of the characteristics of the individual in addition to the parameters discussed so far. The vector c_j is used herein to describe symbolically the characteristics of individual j. Investigators suggest that c_j should include such factors as occupation, family life stage, education, area of residence, and religion.

In passing from the abstract model to the real world, it must be recognized that it is not possible to account for all parameters which may have some bearing upon an activity as complicated as decision-making for consumption. The uniqueness of physical markets and individual consumers surely make both parameters a and c_j incomplete for any finite dimension.

Several economists, Friedman (16) in particular, maintain that consumer purchases are not restrained by income occurring within a specific time increment. Instead, it is suggested that consumption is influenced strongly by current real wealth and future earning capacity. The difference between current income and expenditures takes the form of borrowings and savings. Past consumption habits are also considered important.

The conceptual basis developed herein is static in nature. The consumer is assumed to be able to make the decisions neces-

sary to reach his preferred budget within the time alloted. He is assumed to operate with full knowledge of the options available. But in the real world, human activity is often characterized by a basic and unpredicable element of randomness which prevents the person from ever truly reaching the preferred state.

To account for the stochastic nature of the individual and the incompleteness aspect of the parameters, a disturbance term is envisioned as being appropriate for the model. Calling the disturbance term e_{mj}, a model deemed appropriate for describing quantity of purchases of commodity group m by consumer j is

$$q_{mj} = D_m(p,a,I_j,c_j,e_{mj}). \qquad (17)$$

The form of D_m and the explanatory parameters are assumed to be such that the random variable e_{mj} tends toward a zero value upon aggregating over trials (time) and individuals.

It may be noted that the four parameters in 17 can be separated into two classes, (a) those determined for the individual by the outside world, retail prices and non-price offer variation, and (b) those pertaining to the individual, resources or income, and personal characteristics. Discussion within the text to follow has been divided in the same way.

A Review of Related Empirical Studies

Many studies have been completed pertaining to the demand of consumer products and in particular meat products. Two major types of information have been used. Studies such as Demand and Prices for Meat, Factors Influencing Their Historical Development (4), have been based on time series analysis of data such as are published in U.S. Food Consumption, Sources of Data and Trends, 1909-63 (49). These data represent largely "disappearance" of meat because the estimates of consumption are derived from data on net stock changes, production and imports.

Several studies have used the cross-section data obtained in the nationwide household food consumption surveys (46,47) conducted periodically in the past. These surveys provide information on the quantities of each major cut and kind of meat consumed and/or purchased by households classified by income, urbanization, geographic area, and sometimes occupation. The survey data were obtained by interview and pertain to a one-week period. One of the more detailed analyses of these data is Consumption Patterns for Meat (5). The report Meat Consumption Trends and Patterns (44) summarizes important aspects of the meat consumption situation portrayed by both data sources.

Some studies have treated particular meat products. For

example, Consumer Preferences for Poultry Meat (30) was based on survey material obtained from 50 retailers and nearly two thousand homemakers in West Virginia. Characteristics which consumers look for in selecting poultry were determined. The study also included some experimental work pertaining to alternate methods of displaying and packaging poultry meat.

Consumer Preferences for Pork, Des Moines, Iowa (18) related pork consumption to selected characteristics of households. Comments were solicited on quality aspects of major pork cuts. An experimental method involving photographs was used to determine fat and size preference for pork chops.

In 1960 a pilot study was conducted in Marshalltown, Iowa which provided the basis for the survey on which this thesis is based.[1] A consumer panel of 91 households was used. The objective of the project was largely that of testing procedures for data collection which were ultimately used in the Webster County survey. This research did not lead to a formal publication; however, a thesis titled Product Acceptability in Relation to the Demand for Meat (43) used these data. Several components of acceptability were delineated and related quantitatively to consumer demand.

In summary, research studies pertaining to the factors affecting consumer demand for meat fall into two classes:

[1]Project 1404, Iowa Agricultural and Home Economics Experiment Station, Center for Agricultural and Economic Development cooperating.

those pertaining to consumption of major classes of meat over long periods of time, and those concentrating on cross-sectional data. Some studies have given great concentration to an individual meat item. This study is relatively unique in that it represents an attempt to examine a detailed classification of meat items both from time series and cross-sectional aspects.

DATA SOURCES

The data for this study pertain to consumer-retailer activities in Webster County, Iowa during a seven week period in June and July, 1963. Webster County was selected to be the study area because it provided a desired combination of both rural and urban households. The county contains only one major trading center, that of Ft. Dodge. This aspect led to an efficiency in obtaining detailed time series information on retailing activities. It also fulfilled the aim of basing the study upon a single well-defined somewhat typical retail market.

Although Webster County, Iowa includes only one urban place, that of Ft. Dodge with a population of 30,000 in 1963, its 50,000 people represent households having a wide variety of socio-economic characteristics. Since the distribution of these characteristics are not too much different than for the nation, some conclusions reached in this study may have implications beyond that of the Webster County population. However, it must be recognized that the conclusions reached herein are truly valid only for Webster County during the summer of 1963. The report can only suggest possible truths for other geographic areas. Appendix A provides additional material on the socio-economic structure of Webster County and compares this structure to the nation.

Household Survey

Data for the household phase of the survey were collected by means of a stratified single state area sample in which the areas, or sampling units, consisted of approximately four contiguous housing units drawn at random. Webster County was divided into 24 strata containing nearly an equal number of housing units. The open country made up four strata and small towns contributed another four strata. The remaining 16 strata were located in the city of Ft. Dodge.

All occupied housing units in Webster County constituted the universe for the survey. An occupied housing unit was defined as a room or group of rooms shared by a family or a group of persons or by a person living alone. Group quarters containing more than four lodgers were excluded from the universe.

The sampling frame was formed by use of various maps and supporting information on dwelling unit counts. The city directory was used in Ft. Dodge. Observations from a moving auto supplied the required housing counts in the small towns. In other parts of the county, maps prepared by the Iowa State Highway Commission provided a rough indication of the number and location of housing units by means of dots, making it possible to form block like units.

The selection objective was to select eight sampling units

containing four occupied housing units from each stratum with equal probability. The procedure used was to select eight blocks from each stratum with probability proportional to estimated housing unit count. Next the selected blocks were examined by a field crew in order to obtain a more accurate count of occupied housing units. A sampling unit of contiguous housing units and two potential substitute housing units were then drawn at random from the block. The size of the sampling unit was determined by multiplying by four the ratio of the count obtained by the field crew to the initial estimated count. This procedure produced an initial sample of 779 occupied housing units.

An initial interview was obtained at 624 of the 779 housing units. Of the 155 nonresponses, 63 were refusals and 61 families were found to be on vacation. Various reasons accounted for the remainder of the difference. Preplanned substitutions were made for 126 of these nonresponses by selecting a predetermined alternate within the same block. This gave a total of 750 completed first week interviews. Attrition in the survey panel following the first week brought the total down to 642 useable schedules.

A rotational scheme was used to collect data over an eight week period and yet retain each household in the survey panel for only four weeks.[1] Table 1 illustrates the procedure. Each

[1]Discussion in the next section concerns the omission of the first week of data for each household from the analysis.

Table 1. Pattern[a] of rotation used for panel members, Webster County survey, June-July, 1963

Panel segment	Period covered in diary							
	May 29 June 4	June 5 June 11	June 12 June 18	June 19 June 25	June 26 July 2	July 3 July 9	July 10 Kuly 16	July 17 July 23
1	*					*	*	*
2	*	*					*	*
3	*	*	*					*
4	*	*	*	*				
5		*	*	*	*			
6			*	*	*	*		
7				*	*	*	*	
8					*	*	*	*

[a]An * shows the weeks for which the panel segment provided purchasing data.

of the eight sampling units in a stratum was assigned to a specific one of the eight replacement patterns so as to attain a balance with respect to strata and time periods. The scheme involved dropping one fourth and adding a new one fourth of the total households each week. Thus, every pair of contiguous weeks and the first and eighth weeks contained the same number of common housing units. One half of the total sample was scheduled for interviewing each week.

As may be noted by examining the manner in which the sample was selected, simple sample means and proportions form unbiased estimates of the corresponding population means and proportions. However, one exception should be noted. An apartment house containing 20 households was subsampled by selecting only three households. A minor adjustment could be made in each estimate to compensate for this subsampling. Nevertheless, for this report no such adjustments were made for reasons of simplicity. As a result the estimates provided herein are slightly biased as estimators of the Webster County population.

All interviewing and data collection were conducted by the Statistical Laboratory, Survey Section of Iowa State University. Appendix B provides a one page example of the diary used by the household panel members for recording data on purchases.

Comments on household purchasing data

As already noted, data pertaining to meat obtained from all sources were collected over an eight week period in June and July, 1963. Data were furnished by each of 642 respondents for four weeks.

Data for the first week were based on a simple query concerning meats obtained from all sources during the preceding week. The respondent provided estimates of pounds, expenditure, and cut description from memory. A diary was left with the respondent for recording such data at the time of purchase for each of the following three weeks. An interviewer contacted the respondent every week to check and pick up the diary for the prior week.

Table 2 shows the quantity of meat obtained per week per household from all sources on an interview week basis. It may be noted that data for the first week of interview were

Table 2. Meat obtained from all sources,[a] Webster County survey, June-July, 1963

Week of interview[b]	Beef	Pork	Cold meat	Poultry	Fish
First	4.50	2.29	1.36	2.16	0.62
Second	3.23	1.81	1.07	1.64	0.47
Third	3.17	1.92	1.05	1.37	0.29
Fourth	2.71	2.25	1.09	1.53	0.30

[a]Purchases, gifts, homegrown, etc. in pounds per week per household.

[b]The first week data depended on memory of respondent. A diary was supplied for other weeks. All quantity and price data submitted later in this report are taken from the second, third, and fourth weeks.

about 40 percent greater for most kinds of meat than were the data for the following three weeks. Some decrease in meat consumption as interviewing progressed was anticipated as a result of an expected tendency for people to eat less meat during the hot summer months. However, the size of the decrease noted could not be assigned entirely to this reason.

One plausible explanation for the high first week is that the respondents tended to include both meats which were consumed and meats which were purchased for consumption at a later time. The size of the individual purchases was not significantly greater for the first week, but instead, a greater number of purchases were recorded.

On the basis that asking respondents to record entries in a diary at time of purchase produces less bias than simply asking the respondent to recall last weeks purchases, it was decided to omit all first week data from the analysis. This omission decreased the time period covered from eight to seven weeks. Examination of Table 1 will show that one aspect of balance is lost, but this loss was not considered serious.

Table 3 shows that 14,274 pounds of meat, poultry, and fish were purchased during the second, third, and fourth interview weeks by the 642 respondent households. To this may be added 886 pounds received by gift, homegrown, caught, or other means.

However, it was not desirable to use all of the data

Table 3. Summary data on meat acquisition, Webster County survey, June-July, 1963

	Pounds
Survey aggregates:[a]	
Small lot purchases of beef, pork, cold meat, poultry and fish	13,931
Purchases of veal and lamb	30
Large lot purchases of beef and pork (quarters, etc.)	313
Meat and fish received as gifts, homegrown, caught, etc.	886
Total meat, poultry and fish considered in survey	15,160
Weekly acquisition rate for all meat and fish:	
Per household	7.87
Per person	2.28

[a]Aggregates are for second, third, and fourth interview weeks for 642 households.

aggregated in Table 3. For example, the large lot purchases of beef and pork involved only two purchases; an inclusion of such a purchase in a breakdown of acquisitions by socio-economic classifications would cause some rather grotesque results. Gifts and home-grown items distorted prices. Thus, for all figures and tables to follow, with the exception of Table 4, only small lot purchases of beef, pork, cold meat,

poultry and fish have been included. Table 3 shows that small lot purchases totaled 13,931 pounds which gave a mean weekly purchasing rate of 7.23 pounds per household. A total of 7,067 individual purchases were made for which expenditures totaled $8,064.00.

Figure 1 shows the national time series (49) context in which the Webster County survey was situated. National prices for beef, pork and poultry in 1963 approached closely the mean prices in recent years. A small decline from 1962 prices was recorded for all three. National per capita consumption of pork in 1963 was quite typical of that over the past ten years, while per capita consumption of both beef and poultry approached a value appropriate to their upward trend in recent years. A slight increase in per capita consumption in 1963 over that of 1962 was recorded for all three meats.

A cross-sectional comparison between Webster County and the nation has some value. Such a comparison is provided in Table 4 by elevating the June-July acquisition data for Webster County to an annual basis. However, the author hastens to add that considerable difficulties are encountered in establishing the validity of such a comparison.

First, it should be noted that the U.S. Department of Agriculture time series data include consumption of meat in the form of meat mixture products and consumption away from home such as in cafes. Cold meat products, while handled as a

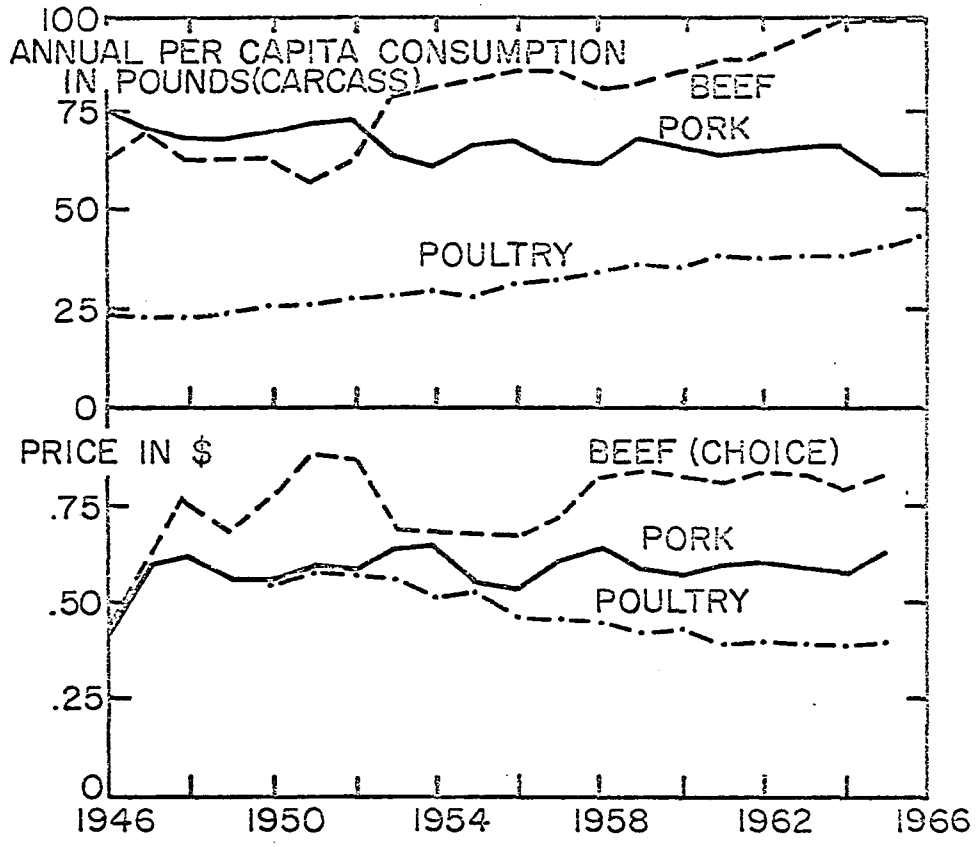


Figure 1. Retail price and per capita consumption of beef, pork and poultry (49), United States, 1946 to 1966

separate class in Webster County, were included in the basic source meat classes in the time series data. In addition, the Webster County data pertained only to acquisitions while the other two sources represent an estimate of consumption; consequently, withdrawal from storage during the summer months

Table 4. Comparison of Webster County annual per capita meat acquisition data to other data sources

Item	USDA time series (1963) Total meat consumption in all forms[a] (pounds)	1955 Food consumption survey Meat used at home[b] (pounds)	Webster Cty. survey Acquisitions only[c] (pounds)
Beef	69.7	63.1	44.9
Pork (including cured)	60.7	57.8	29.1
Cold meat	[d]	18.3	15.9
Lamb, veal and other	20.3	13.8	0.2
Poultry	37.9	35.8	23.0
Fish	13.6	20.0	5.4

[a]Retail-equivalent pounds, source: (49).

[b]Source: (46). Consists of meat used at home from "all sources" converted to annual per capita basis by dividing by the survey count of "economic families." Data were collected for one week by interview in April to June, 1955.

[c]Webster County survey data on purchases, gifts, home-grown, etc., for second, third, and fourth weeks of interview.

[d]Included in other classes.

was not included in the Webster County data.

An earlier survey (43) of 91 households in Marshalltown, Iowa, during April-May 1960, showed purchases to amount to about 80 per cent of actual consumption. Nonpurchase acquisitions were extremely small for this study since no rural households were included. The 20 per cent difference was attributed largely to withdrawals from inventory in the spring months. The survey was conducted by procedures similar to that of Webster County; however, data on actual consumption were also collected by means of an interviewer taking beginning and ending home storage inventory. The purchasing rate of 128 pounds per person per year for this study compared closely to the 119 pound acquisition rate for Webster County.

In attempting to reconcile the 119 pound acquisition figure for Webster County to the total of 202 pounds given in the time series data, rough estimates can assign only about two thirds of the difference to consumption away from home or in the form of meat mixtures and to seasonality factors pertaining both to a lower summer consumption rate and to a net removal from storage. The remaining difference can perhaps be attributed to an actual variation in the consumption rate between Webster County and the nation. Some sampling variation of course also enters into the Webster County data and the mechanical aspects of the interviewing situation may be responsible for some of the difference. An inclusion of the

first week of interview data would greatly reduce the difference.

Before departing from the brief comparison to the national situation, it may be meaningful to compare Webster County prices. The price per pound of all pork was shown to be $0.57 in Figure 1 for the Nation; the Webster County price was $0.60. The national price was $0.39 for poultry as compared to $0.38 in the survey. A close comparison cannot be made for beef since the national data are on the basis of "choice" grade while a significant amount of ungraded and "good" grade beef was sold in Webster County. Nevertheless, the Webster County beef prices seem reasonably close to those of the nation after taking this factor into account.

Data on Marketing Activities

Not only were data collected from consumers in Webster County, but in addition, considerable data were collected on retail marketing activities. The survey group here consisted of the eight largest meat retailers among 68 retailers of meat within the county. These eight retailers accounted for about three fourths of all meat purchases by the consumer panel. Only about 5 percent of the panel's purchases were made outside the county and about 20 percent were made at the other sixty local retailers.

A weekly interview-observation program collected data

on meat pricing, promotion, and inventory-stock movements. The price data on meats pertained to the "non-special offer" price of twenty-three standard cuts on Mondays for some stores and Tuesdays for others. An observer recorded data on all in-store promotion media on either Thursday or Friday. A check-off list of promotional activities was used. Such things as size of promotional sign, whether a price reduction was being offered, and display characteristics were recorded. The store manager was also queried about promotional activities conducted during the week.

All newspaper advertising by meat retailers in the local newspaper was clipped during the study period. Practically all of this advertising was conducted by the eight stores surveyed. A few radio advertisements were used by meat retailers but the frequency of the use of this media was so low that these data were ignored for this study even though available.

Information on the other aspects of meat marketing was collected during the survey period such as data on the meat items wholesalers and packers were emphasizing each week. However, an initial review of this information indicated that they could be related to consumer demand during the survey period only with extreme difficulty if at all. The main problem here was a lack of systematic variation within the short survey period.

ANALYSIS OF SOCIO-ECONOMIC EFFECTS ON DEMAND

The conceptual development presented earlier herein suggested the following model for analyzing quantity demanded by consumers:

$$q_{mj} = D_m(p,a,I_j,c_j,e_{mj}) \quad . \tag{18}$$

Vectors p and a refer to prices for all commodity and non-price offer variations respectively. These are factors external to the consumer and are not of particular concern in this chapter. Parameter I_j refers to income of consumer j while vector c_j refers to his other socio-economic characteristics. Variable e_{mj} is a stochastic disturbance term. Variable q_{mj} indicates quantity of commodity m purchased by consumer j.

The current objective is to determine the important socio-economic factors, that is, the important elements of c_j, and to quantitify the relation of c_j and I_j to demand. These are factors peculiar to the individual consumer.

Prior discussion concerned the demand of an individual idealized consumer. However, from a real world viewpoint, a household is more likely to be the actual decision-making unit. The measurement of demand by a household is undoubtedly a more acceptable unit from the standpoint of survey mechanics, and course, as already noted the individual household was the survey unit here. Thus, in all the analysis to follow, the

socio-economic factors considered pertain to those of the household.

The material in this chapter has been divided into three sections. First, an overview is presented on how purchasing patterns differed for households possessing different socio-economic characteristics. Attention is then given to developing an empirical model suitable for quantifying the relations suggested by the overview. Finally, the developed model is used to present specific elasticities and to provide measurements of reliability.

An Examination of Purchases for Households Classified by Socio-Economic Attributes

When organizing the Webster County survey it was hypothesized that both the rate and composition of meat consumption were affected significantly by many socio-economic attributes. Data were collected from the panel households on the following characteristics:

(a) Number of persons in the household

(b) Household composition i.e. adults only, married couple with children of pre-school age, etc.

(c) Sex of household head

(d) Age, educational attainment, occupation, and industry of work for household head

(e) When appropriate, age, educational attainment, occupation, and industry of work for wife

(f) Family income

(g) Residency characteristics i.e. duration and location.

Preliminary data aggregations were made after classifying the panel households by all of the above characteristics. This preliminary work suggested that concentration be given to (a) size of household, (b) composition of household, (c) household income, (d) age of household head, (e) education of household head, and (f) occupation of household head. Data on purchases for the second, third, and fourth weeks of interview were aggregated using each of these six characteristics as a one-way control. Tables were constructed to provide data for each of eighteen meat groups on mean quantity and mean expenditures per family and per person, mean price paid, frequency of purchase, and mean size of purchase. Figures 2 through 5 were developed as a simplification of the data in these tables.[1]

In defining the eighteen meat groups used in the basic data tables, an attempt was made to follow the general classification scheme used by the meat industry. Cut classifications used in advertising and technical literature on meat cutting and preparation were reviewed (28). Of course, attention was also given to forming classes containing a large enough number of purchases to provide meaningful group estimates. The eight-

[1]It should perhaps be noted that the means per person illustrated in Tables 2 through 5 are weighted means, the weights being the size of household.

teen classes were collapsed to twelve for Figures 2 through 5 and for the regression analysis to follow. Table 21 in Appendix C provides additional details on the classification scheme used in various parts of thesis and data on number of purchases, mean price paid, and mean quantity per week per person.

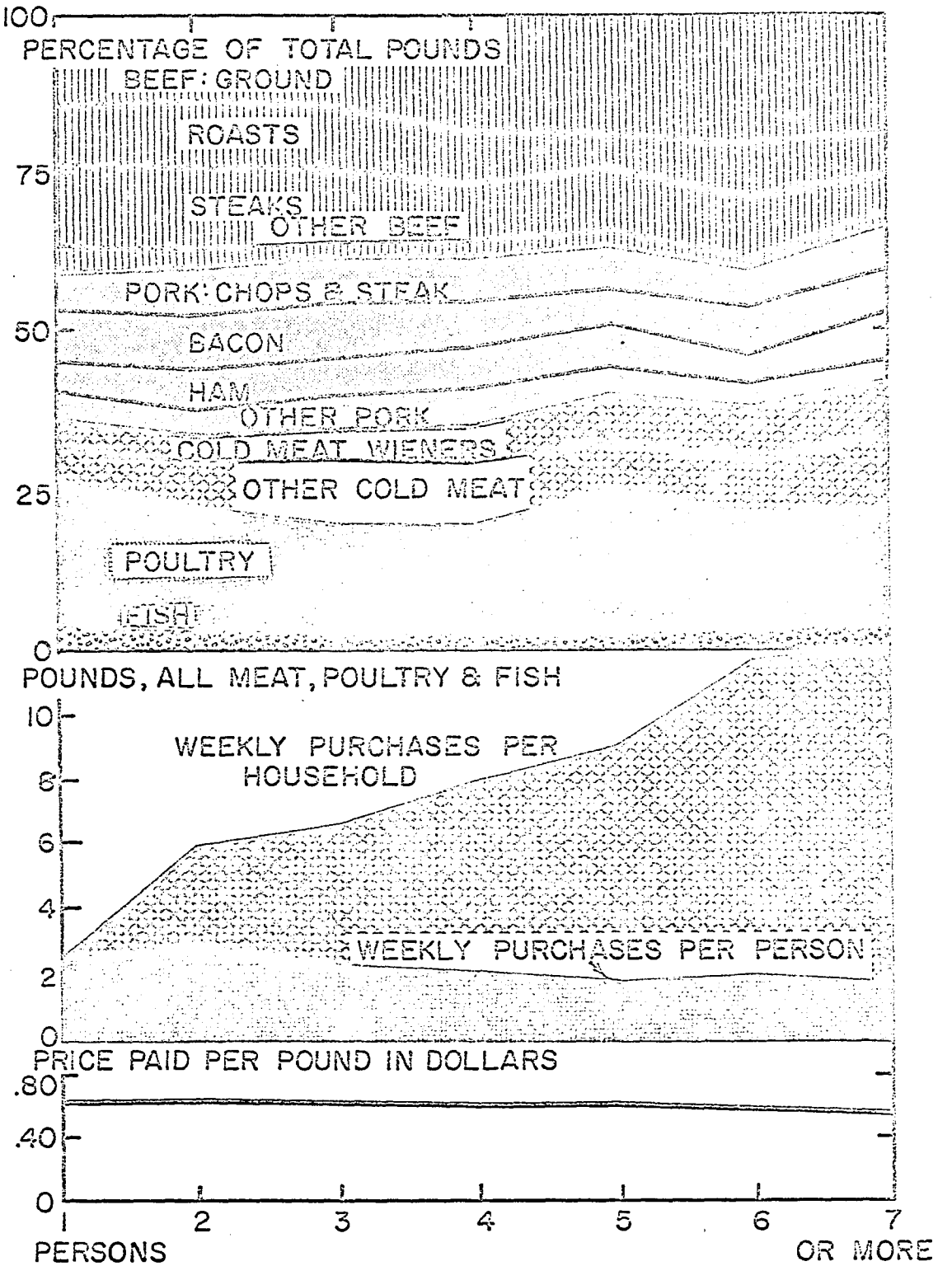
Household size and composition

Household size appears to be a major factor influencing volume of purchases per person. Figure 2 shows that while size increased from 2 persons to 7 or more persons per household, purchases of all meat, poultry and fish per person dropped from 2.9 pounds per week to 1.6 pounds. This lower purchasing rate can be related to the lower consumption by children in the larger families. Families with children (Figure 3) purchased at the rate of 1.9 pounds per person as compared to a rate of 2.8 pounds for non-children households.

Figure 2 shows that purchases per household amounted to 12.1 pounds per week for households containing seven or more members. The amount paid for all meat increased less rapidly than did quantity since the larger household paid nearly ten cents less per pound than smaller ones.

The larger household's purchases emphasized generally the lower cost meats. And again within any general kind of cut, the lower cost portions were bought. Proportionally more hamburger and less beef steak and roast were purchased. Cold

Figure 2. Percentage distribution of pounds of meat purchased by size of household, mean purchases, and mean price paid, Webster County survey, June-July, 1963


100
PERCENTAGE OF TOTAL POUNDS
BEEF: GROUND
ROASTS
75
STEAKS
OTHER BEEF
PORK: CHOPS & STEAK
50
BACON
HAM
OTHER PORK
COLD MEAT WIENERS
OTHER COLD MEAT
25
POULTRY
FISH
0
POUNDS, ALL MEAT, POULTRY & FISH
10
WEEKLY PURCHASES PER HOUSEHOLD
8
6
4
WEEKLY PURCHASES PER PERSON
2
0
PRICE PAID PER POUND IN DOLLARS
.80
.40
0
1
2
3
4
5
6
7
PERSONS
OR MORE

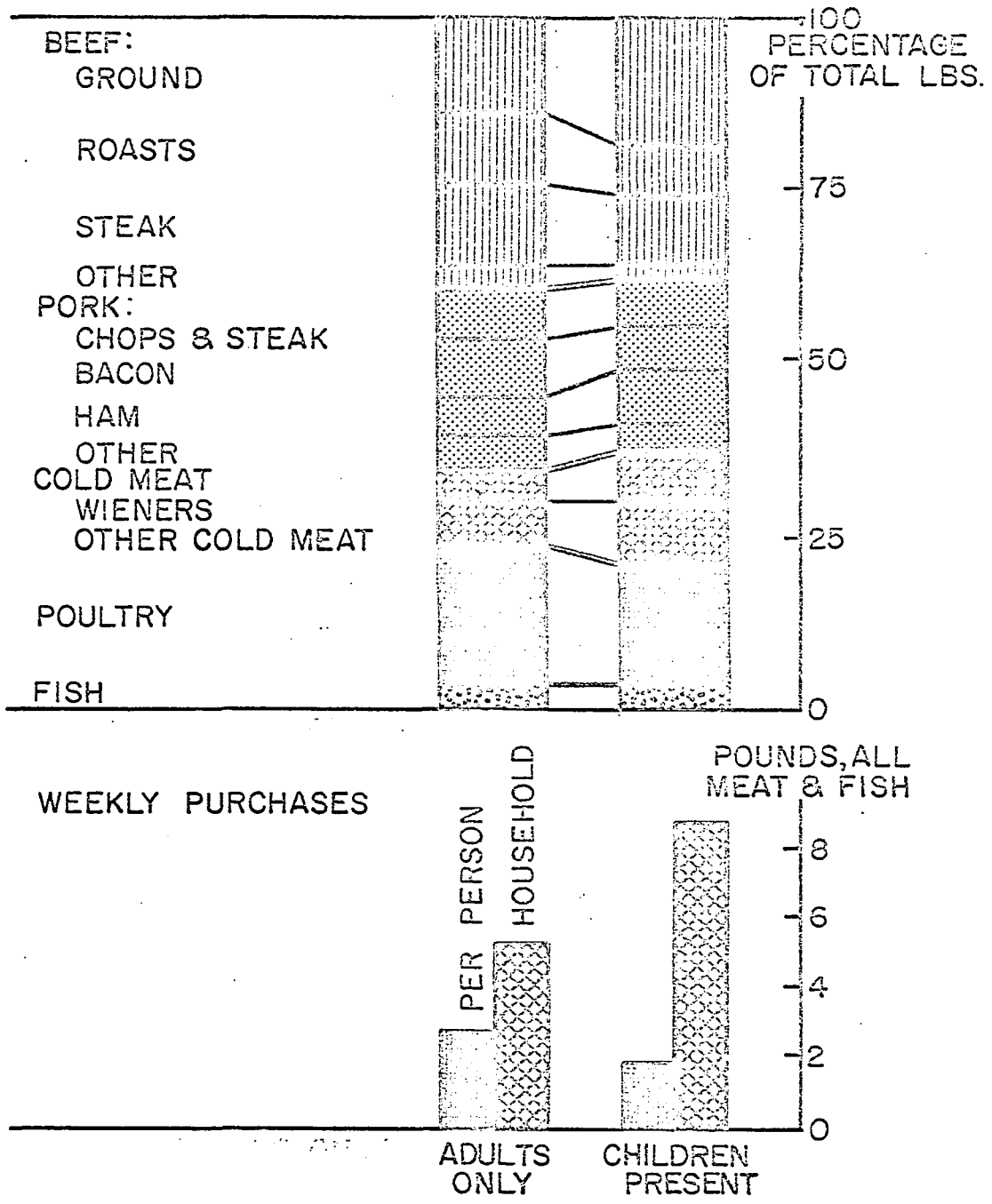


Figure 3. Percentage distribution of pounds of meat purchased by whether family contains children and mean purchases, Webster County survey, June-July, 1963

meat was purchased by the larger households at a percentage rate which was nearly twice that of the one or two person households.

Little evidence was obtained for a family size effect on general categories of meat. A rather marginal decrease in the proportion of pork, beef, and chicken is indicated. These are offset by an increase in consumption of cold meat.

Much of the effect of household size on the pattern of purchases can possibly be explained more clearly by classifying the respondents into children versus non-children families. The proportion of ground beef purchased was 50 per cent higher for families with children while the purchase of beef roast and steak showed the opposite situation. Children liked wieners and other cold meats and their families' purchases were also 50 per cent higher here. Households without children gave more emphasis to bacon while families with children preferred ham.

However, the overall proportions of pork, beef, and chicken purchased seems to be influenced only slightly by the children factor. The increase in the proportion of cold meats purchased was offset by small decreases in the proportion of all pork, beef, and chicken for families with children.

Household income

Pounds of meat purchased per person changed only marginally as income increased through the major part of its range.

Households with incomes above $10,000 annually purchased only 0.3 pounds more per person (14 per cent greater) than did households earning from $1,000 to $4,999. One exception to this extremely mild income effect was that households with incomes under $1,000 purchased at a rate of only three fourths the per capita mean.

Nevertheless, an examination of Figure 4 indicates that a rather strong income effect was present in pounds purchased per household. However, it must be noted that size of household was strongly correlated with income up to the mid-point; purchases per household climbed also as the households became larger. Most of the households with low income consisted of older persons. The average age of the household head for the households with under $1,000 in income was 75 years while the average age of the $1,000 to $2,999 income group was 64 years.

As may be expected dollars spent per household also made a rather sharp climb as income increased. The price paid per pound increased from $0.49 to $0.71 when moving across the entire income range. But if the extreme groups at each end of the income range are disregarded, an increase from $0.56 to $0.63 was noted. This latter change again indicates that income as a factor in the kind of meat consumed with regards to price was not especially pronounced except in the extremely high or low income groups.

Figure 4 also provides information on the composition of

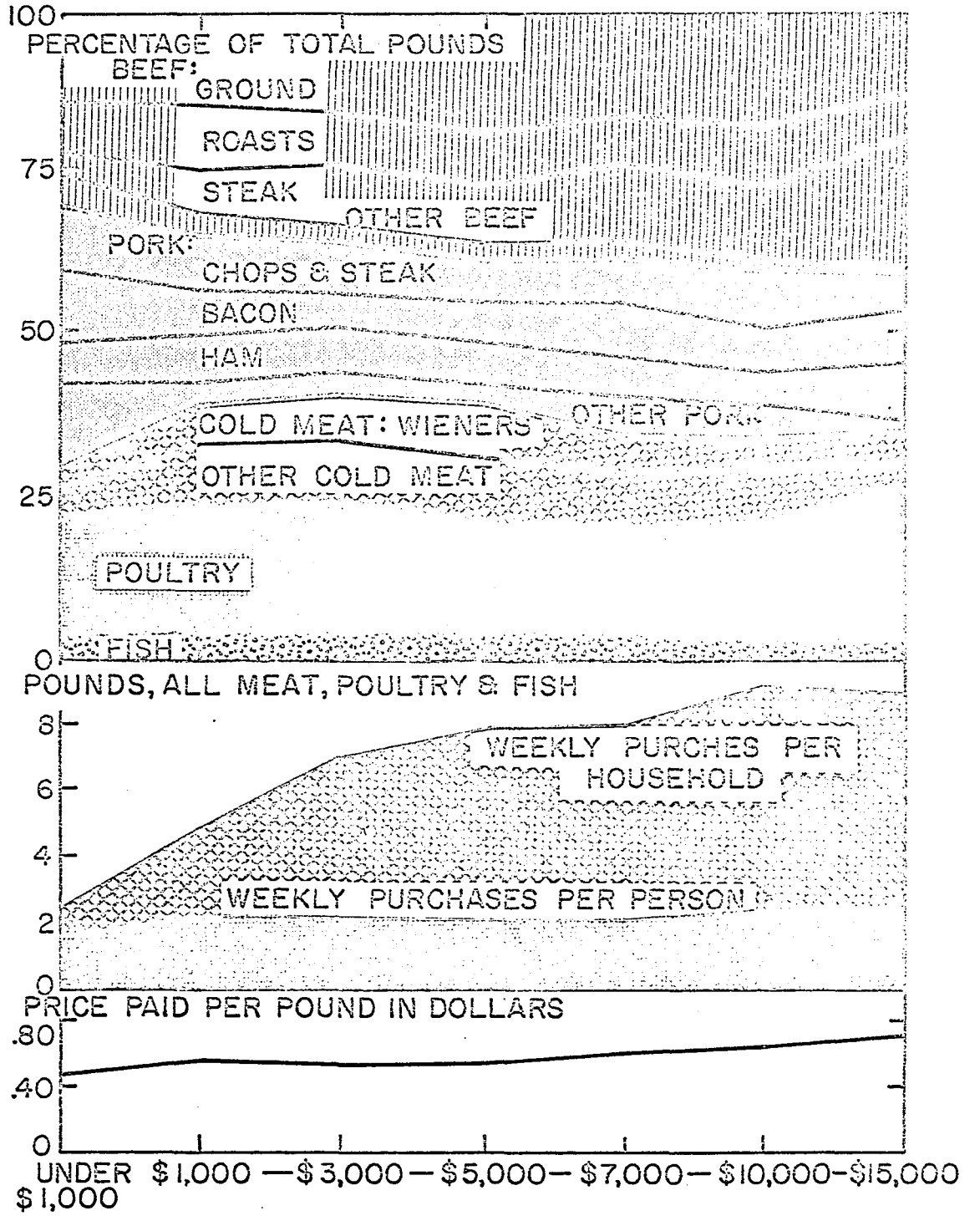


Figure 4. Percentage distribution of pounds of meat purchased by income of household, mean purchases, and mean price paid, Webster County survey, June-July, 1963

meat purchased by different income groups. The emphasis the extremely low income, aged consumer places on pork clearly stands out. But such emphasis on pork cannot be assigned entirely to income since in contrast 24 per cent of the meat purchased by households with incomes from $3,000 to $6,999 was pork as compared to 26 per cent for households with incomes of $7,000 and above. The age of the household head was greater by only a small margin for the higher income group.

Despite the initial appearance of Figure 4, age and income can hardly be evaluated as important factors in overall pork consumption in Webster County. Total meat consumption by households in the first two income groups amounted to only about 9 per cent of the meat consumption by all income groups. The per cent of total dollars spent was even less.

In turning to purchases of meats other than pork, a quite clear increase in the proportion of beef purchased was associated with an increase in income. The pattern on poultry purchases is not distinct. The extremely low income household purchased little cold meat, but cold meat purchasing also decreased with income for the higher income groups.

The proportion of total meat purchased as ground beef appeared to generally increase with income. In addition higher income households paid more for their ground beef by purchasing ground round or chuck much more often. The total proportion of meat purchased as beef roasts remained constant, but higher

income households were more likely to purchase something other than a chuck roast.

Beef steak purchases in general increased by a rather extreme amount as income increased. In addition households with high income concentrated on t-bone and sirloin while lower income households purchased largely round and chuck steaks. Households with an income below $7,000 purchased only .06 pound of t-bone or sirloin steak per person per week while households with an income of $7,000 or more purchased at the rate of .21 pound per person.

The mixture of the individual cuts of pork changed little with income. If the first two extremely low income groups are disregarded, bacon showed some increase in quantity with income. Ham followed an uncertain pattern which can probably be interpreted as no income effect on quantity being present. But if dollars spent per person rather than percentages are taken into account, both ham and bacon showed sizable increases for the higher income groups.

Age of household head

Maturation or stage in life of the household can be indicated reasonably well by age of household head. Figure 5 provides information on meat purchases according to this household characteristic.

Purchases per person increased from about 1.8 pounds per week for households with the head under 45 years of age to 2.5 pounds for households with the head having an age of 45 years

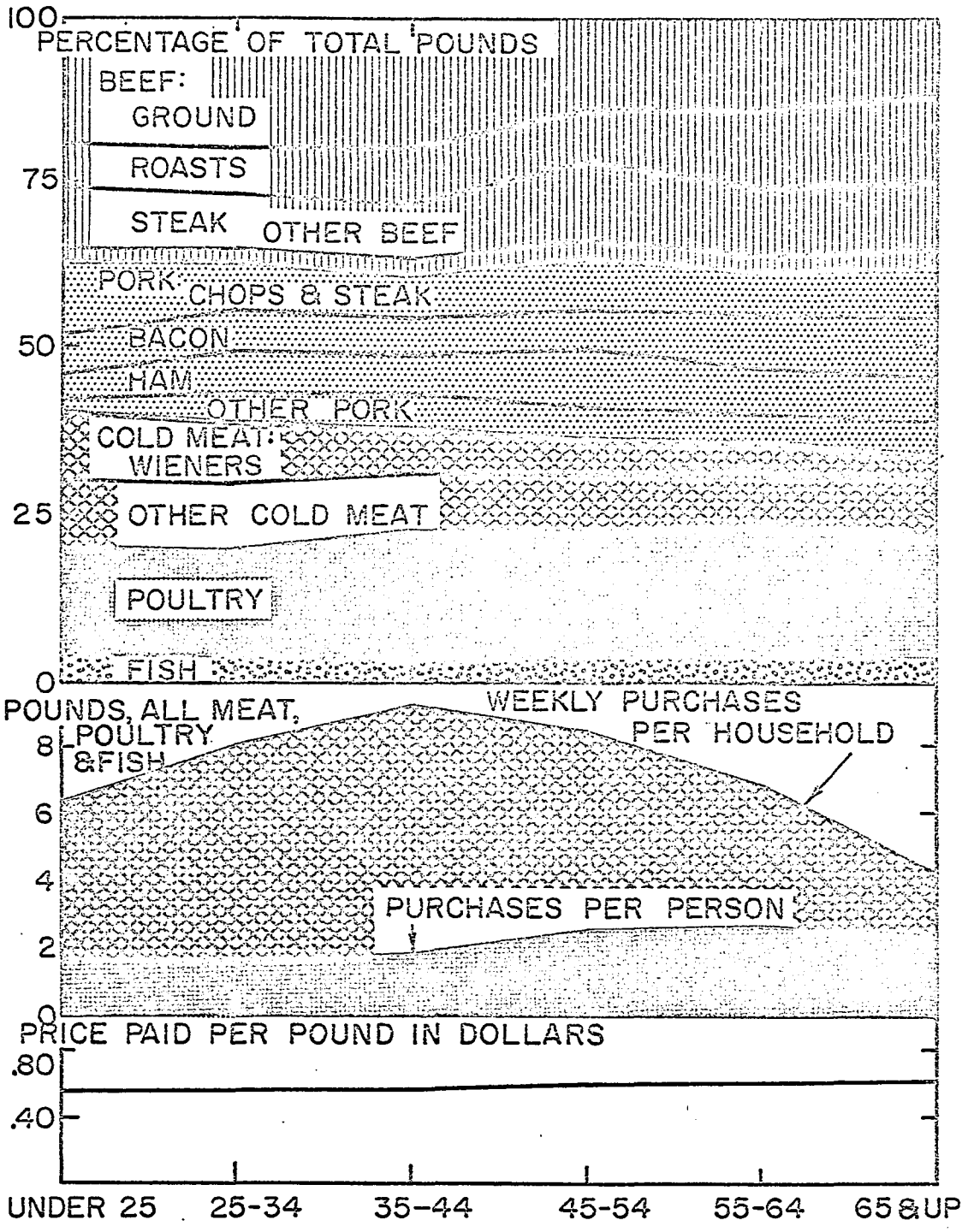


Figure 5. Percentage distribution of pounds of meat purchased by age of household head, mean purchases, and mean price paid, Webster County survey, June-July, 1963

or more. Age made very little difference within these two divisions. Thus, it is suggested that age by itself was not causing the difference in mean purchases per person, but instead, the difference was caused largely by whether or not children were members of the household.

The effect of children in the household also shows up strongly in the mixture of meats purchased. Younger households gave more emphasis to ground beef and cold meats, especially wieners, and less emphasis to roasts. Nearly 9 per cent of the meat purchased by households with the head under 35 consisted of wieners while the comparable figure was only 3 per cent for households with the head being 55 years or older. But in this case, the emphasis placed on wieners cannot be attributed entirely to children because young couples without children purchased wieners at very nearly the same as those with children.

The more mature households purchased a little more bacon and ham than did younger families. But again the ham situation contrasts with the children versus non-children comparison since ham accounted for a higher proportion of the total meat purchases by families with children than it did for families without children. The real situation was that young households without children purchased such a small amount of ham that in the aggregate, younger families also purchased less ham.

In summary, the more mature households gave beef the same emphasis as the younger households, purchased more pork and poultry, and purchased much less cold meat, especially wieners.

Education of household head

The educational level of the household as measured by the education of the household head appears to be a negligible factor in the meat purchasing patterns of households in Webster County. Mean weekly purchases per person were nearly constant for all education groups. Price paid per pound increased slightly with education, but this effect can be more logically explained as the result of the higher income of more educated persons. The group defined by the household head having 8 years or less of education emphasized pork a little more. However, this group's pattern was strongly influenced by elderly low income households for whom it has already been noted pork was especially important.

Households associated with a higher level of education gave less emphasis to cold meats. It is suggested that this may be a result of less preparation of away-from-home lunches. Education was related to greater purchases of the higher priced cuts such as t-bone and sirloin steak and roasts other than chuck.

Occupation

The occupation of the household head was related to minor

changes only in purchases. Mean per capita purchases were nearly identical for all occupations. An exception was that farmers purchased at only about three fourths the mean rate, but when home grown meat was considered, the difference became insignificant. Households in the "white collar" type class purchased pork at a rate of about 3 percentage points below the mean rate for all households of 25 per cent. The income effect already noted was present of course when occupations were separated according to income.

Summary comments on quantity purchased

Pork purchases as a proportion of total meat purchases appear to be related more closely to age of household head than any other socio-economic characteristic examined. Lower income households purchased more pork, but the decrease in pork purchasing as income increased becomes nonexistent when the large number of older persons (usually retired) are disregarded. Nevertheless, the mix of pork cuts seems to vary with income; higher income households concentrated more strongly on ham and purchased all other pork except bacon at a lower rate.

Beef purchases as a proportion of total meat purchases can probably be related more closely to income than to any other socio-economic characteristic considered. Only 30 per cent of the quantity purchased by the lowest income group was beef while 42 per cent consisted of beef for the highest in-

come group. The increase in beef purchasing as income increased was even stronger when dollars spent is considered; about 48 per cent of the expenditures made by the highest group was for beef. However, an examination of the extremes in income may be somewhat misleading because a majority of the respondents were classed in the middle income groups for which the changes in purchasing pattern with income was much more mild (see Table 18 in Appendix A).

A relatively strong change in the mixture of beef purchases was related to income. The high income groups were especially strong on t-bone and sirloin steaks and roasts other than chuck. They, in general, purchased the higher priced portions.

Cold meat purchases generally decreased with income. The younger families, both with or without children, were heavy purchasers of wieners. Poultry purchasing could not be related to any of the socio-economic characteristics considered. Farmers, while not especially heavy purchasers of chicken, were strong consumers by reason of their own production.

The discussion up to this point may appear to suggest that the socio-economic factors considered herein have a rather strong effect on purchasing habits. Thus, the author must hasten to add that this appearance is strongly influenced by the extreme groups displayed in the distributions. In addition, a classification by a particular factor also dis-

plays the aggregated effect of several factors by reason of the correlation of factors (for example, household size and income). Some indication of the mildness of these socio-economic effects can be obtained by dichotomizing the survey data according to the factor of interest.

Households having an income below the median level for the group accounted for 43 per cent of all meat, poultry, and fish (pounds) purchased. Again, they purchased 43 per cent of all pork and 42 per cent of all beef. Only a minor change is made by looking at dollars since this group contributed 41 per cent of all expenditures on meat and fish. But the lower income half purchased only 26 per cent of the t-bone and sirloin steak purchased. The mixture of individual cuts changed much more by income than did any broad class such as all beef or all pork.

In dividing the survey group into equal parts by age of household head, the lower age group purchased 60 per cent of all meat, poultry, and fish. Again, this group purchased 60 per cent of the beef and 58 per cent of the pork.

Households containing children accounted for 70 per cent of all meat, poultry, and fish. They purchased 69 per cent of the beef and 69 per cent of the pork. The greater emphasis given to wieners by the younger families shows up in the datum that 83 per cent of all wieners were purchased by households with children.

Quantifying the Relationships

Discussion in the prior section concentrated upon uncovering relations between meat purchasing habits and the socio-economic characteristics of the household. Many potential relations were uncovered. The goal of the current section is to construct an empirical model suitable for quantifying these relationships.

The form of the demand function D_m was not specified by the demand theory presented earlier. Representations linear in the parameters but not necessarily linear in the independent variables have usually been used in other budget studies (2,31, 32,35,43). Such a representation was considered adequate for this study.

As noted earlier, the empirical model for the current section need not consider the relation between p and a and quantity demanded. Thus, the empirical model can be written for any meat m as

$$q_j = \beta_0+\beta_1 X_{1j}+\beta_2 X_{2j}+\ldots+\beta_s X_{sj}+e_j. \qquad (19)$$

The variables X_{hj}, h=1,2,...,s, represent both levels and functions of levels of various economic factors previously represented symbolically by I_j and vector c_j. As will be noted later several forms of X_{hj} were tried.

The model can be written such that the expectation of the random disturbance term e_j is zero. All e_j and $e_{j'}$, $j \neq j'$ are

assumed to be independent; such an assumption is consistent with the earlier basis assumed for consumer decision-making. The variance of e_j is not assumed to be the same for all consumers.

The distribution of e_j is not necessarily assumed to be normal. Rather, for making statistical tests when fitting the model by classical least squares, regression methods, an asymtotic property of regression coefficients is relied upon for an approximate test.[1] "For a broad category of sampling functions, which includes the least-squares regression coefficients as a special case, it follows from the central limit theorem and its extensions that the distribution will, for large samples, but otherwise under very general conditions, be asymtotically normal" (50, p. 213).

Since the form of the function D_m was not known, several different combinations of variables were tried to represent the socio-economic factors of the households. Three methods for representing household income were tried. These were (a) a third degree polynomial, (b) logarithm of household income, and (c) logarithm of income per household member. Size of household was entered initially by a third degree poly-

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[1]The researcher also recognizes that the tests used herein have been biased by the use of preliminary analyses of the data for determining which explanatory variables to include in the model.

nomial. The presence of children was handled by a -1, +1 variable. Age and educational attainment by the household head were entered linearly. The initial model included variables to account for a linear component of interaction between (a) household income and presence of children, (b) size of household and presence of children, and (c) household income and size of household.

The commonly accepted least squares procedure was used to estimate the β_h coefficients for each of thirteen meat classes and four aggregations. Meat purchases were treated in the form of (a) pounds per week per household member, (d) dollars spent per week per household member, (c) pounds per week per household, and (d) proportion of total meat purchases.

In order for the usual linear regression estimates of the β_h to be minimum variance estimates, the error variable e_j must have a common variance for all j. To determine whether this requirement was met, the 642 households were divided into seven nearly equally sized somewhat homogeneous socio-economic groups. The criteria for this grouping involved largely income and household composition; details will be given in a later section.[1] Each of the seven groups were split at random. Mean weekly consumption rates per person were computed for each of 19 kinds of meat items for each of the fourteen groups of households. These means enabled the computation of a 19

[1]See page 83.

degrees of freedom error variance estimate for each of the seven socio-economic groups.

A Bartlett's test for homogeneity of variance produced a chi-square value of 57.7 which is highly significant. Consequently, it was decided to weight the observations by the inverse of the standard error estimates when running the regressions on both pounds and dollars per household per person. That is, both the independent and dependent observation data for any particular household was multiplied by the inverse of the standard error estimate for the socio-economic group of which it was a member. The same weights were used for the regressions for all kinds of meat.

Several regressions involving different explanatory variables were completed for each of the thirteen meats and four aggregations in order to determine the most satisfactory model. Pounds of meat per person was used as the dependent variable here.

The second and third degree terms for size of household were dropped immediately since these coefficients were not statistically significant for any of the thirteen meats. The three linear interaction terms (income by household composition, size by household composition, and income by size) were found to be non-significant for nearly all meats. The only significant result was that households which were small and did not contain children were more sensitive to income in

purchasing beef steak.

Each of the three methods for representing the income effect (third degree polynomial, logarithm of income for the household, and logarithm of income per person) performed about equally well in terms of explained variation. Each accounted for slightly more variation for some meats, but in no case was the explained variation greater significantly. From a simplicity standpoint the use of the third degree polynomial to explain income was eliminated. It was ultimately decided to use the logarithm of household income for the analysis to follow. The use of the logarithm of income per person added an element of complexity for determining the effect of the size of household since size entered the model at two different points. However, it should perhaps be noted that the use of income per person explained more variation in quantities purchased than did household income alone for models not including size as a separate linear additive component.

The education effect was entered into the model by including a linear term for years of schooling completed by the household head. The only significant effects determined were that purchases of cold meats and bacon decreased with an increase in education.

From the regressions using pounds per week per person, it was concluded that quantity could be related most satisfactorily to the socio-economic variables considered by the

model

$$q_j=\beta_0+\beta_1 \log X_{1j}+\beta_2 X_{2j}+\beta_3 X_{3j}+\beta_4 X_{4j}+e_j \ , \qquad (20)$$

where

X_{1j} = household income,

$X_{2j} = \begin{cases} -1, & \text{if household contains children;} \\ +1, & \text{otherwise.} \end{cases}$

X_{3j} = number of household members,

X_{4j} = age in years of household head.

The explained variation was significant statistically at the 0.05 level for all meats. The coefficients were converted to elasticities[1] and are presented in a later section as Table 5 along with the t values. These t values of course pertain to a test of the coefficient against zero conditioned upon fitting the other three variables in the model.

Dollars of meat purchased per week per person were also fitted to the above model. Table 7 contains the results. Some regressions were completed using pounds per household (not per person); however, the coefficients obtained possessed much greater random error.

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[1]All elasticities were computed at the means. That is for explanatory variable X_{hj},

$$\text{estimated elasticity} = \beta_h X_{h\cdot}/q \ .$$

where the dot subscript represents an arithmetic mean over all households.

purchased. Significant results were obtained only for beef and cold meats (Table 6). For these regressions the weights developed for the regressions on pounds per person were not used.

Nature of results

The conceptual model envisioned a relationship between the socio-economic variables and quantity demanded. The nature of the relationship envisioned was that a shift in the value for any socio-economic variable would lead to a corresponding shift in quantity demanded. The purpose of the linear regression model constructed in the last section is to approximate the effect on demand of a shift in any one of the four socio-economic variables. That is, the model represents an attempt to show the effect on demand of such actions as increasing a household's income by say 50 percent, or adding another member to the family.

It was of course not possible to alter the characteristics of the survey households in order to measure the effect on demand. Rather, it was only possible to examine the differences in demand for households already possessing particular characteristics.

The empirical model can only suggest real world relationships which may or may not be true. But nevertheless, the relationships so suggested when fitted into the results obtained by other research methods can contribute to an under-

standing of real world situations. In cases such as this one in which humans are involved, the non-experimental approach often represents the only choice available for collecting a complex set of data in a realistic setting. One must interpret the results attained herein within this context.

Multicollinearity

As noted above it was necessary to accept natures manipulation of the socio-economic variables. And nature, being what it is, does not always assign the values most conducive to valid research. Rather strong correlations were noted earlier between potential explanatory variables. For example it is widely recognized that a high level of education is associated with a higher than average level of income.

Among the four dependent variables finally selected the highest degree of correlation was between household composition and size of household. That is, families containing children were larger. The coefficient of correlation obtained when household composition was coded by a -1, +1 variable, depending upon whether the household did or did not contain children, was .78. Correlation coefficients between age and these two variables approached closely .60. The correlation of the logarithm of family income with the other variables was near .30.

The correlations between the explanatory variables was not large enough to cause a sizeable error in estimating any

of the four coefficients used in the final model. Regressions completed for which one or more of the independent variables were dropped produced coefficient estimates having nearly the same error. However, it must be recognized that all of the coefficient estimates used in the conclusions herein would have been different had the decision been made to include another or possibly to exclude one of the four independent variables. For example, ignoring the size of household variable altered the coefficient for household composition, because that coefficient then explained some of the variation in purchasing which was previously explained by size of household.

Empirical Results

An earlier part examined the distribution of meat purchases and mean purchasing rates for the survey group when classified by various socio-economic factors. Several potential relationships were uncovered here. Attention can now be turned to using the regression model just developed to quantify the relationships and to add a measurement of reliability.

In particular, it was noted earlier that purchases per person decreased as the household size became larger. It was suggested that this situation may be a result of the larger families containing a larger proportion of children, for whom meat consumption is lower. Table 5 shows a significant

decrease in purchases per person of most meats for households containing children, but in addition it also shows that purchases per person decreased significantly for most meats as household size increased even when household composition remained constant. Households containing children purchased 29 percent less meat, poultry and fish person than did households containing only adults after taking into account the income, size and age factors. The elasticity coefficient of -.22 for size for all meat, poultry and fish indicates that a doubling, or 100 percent increase in family size, was accompanied by a decrease of 22 percent in purchases per person. Again, this coefficient assumes all other factors remained constant. The model suggests that the addition of children to a household containing only adults would lead to a drop in consumption per person from both the size and household composition standpoints.

An examination of Figure 5 earlier suggested that age of the household head by itself may not be associated with an increase in purchases per person. The conclusion was reached even though households having a head above 45 years in age purchased meat at a rate about one-third higher per person than did households having a younger head. Table 5 validates this conclusion. It indicates that age of head was not related to aggregate purchases of meat, poultry and fish but age was related to individual kinds of meat. Older families

Table 5. Elasticities of quantity demanded for selected household characteristics, based on purchases per person, Webster County survey, June-July, 1963

	Income		Composition		Size-household		Age of head			
	Elasticity[a]	t value[b]	Coefficient[c]	t value[b]	Elasticity	t value[b]	Elasticity	t value[b]	F	R^2
Beef:										
Ground	.25	1.88	.34	2.22	.02	.22	-.35	-2.08	2.61	.016
Roasts	.55	2.82	.34	1.50	-.28	-1.86	.54	2.17	8.59	.051
Steak	1.20	6.12	.29	1.27	-.64	-4.15	.19	.73	15.33	.088
Other beef	.06	.21	.75	2.43	-.20	-.99	.01	.03	5.68	.035
Total beef	.58	5.08	.35	2.64	-.26	-2.86	.04	.28	12.86	.075
Pork:										
Chops & steak	.08	.46	.49	2.31	-.14	-.99	-.47	-1.99	3.08	.019
Bacon	.40	2.53	.40	2.14	-.28	-2.27	.20	.97	9.07	.054
Ham	.63	2.51	.15	.38	-.30	-1.53	.54	1.68	3.70	.023
Other pork	.30	1.10	.05	-.16	-.54	-2.59	-.01	-.04	2.43	.015
Total pork	.35	2.81	.27	1.82	-.29	-3.00	.07	.42	9.06	.054
Cold meat:										
Wieners	-.01	-.08	.21	1.08	.14	1.06	-.91	-4.23	6.86	.042
Other	-.02	-.11	-.06	-.39	-.33	-3.13	-.20	-1.12	3.21	.019
Total cold meat	-.01	-.13	.04	.29	-.16	-1.79	-.46	-3.13	3.11	.019

[a]Based on model using log(household income).

[b]t value for regression coefficient used in estimating elasticity tested against zero.

[c]Magnitude of coefficient represents the proportional adjustment for households containing only adults relative to households containing children.

Table 5 (Continued)

	Income		Composition		Size-household		Age of head			
	Elasticity[a]	t value[b]	Coefficient[c]	t value[b]	Elasticity	t value[b]	Elasticity	t value[b]	F	R^2
Poultry	.41	2.33	.38	1.85	-.07	-.51	.45	1.98	5.85	.035
Fish	.35	1.46	.25	.91	-.33	-1.75	.01	.05	2.65	.016
All meat, poultry & fish	.41	4.78	.29	2.95	-.22	-3.33	.06	.52	16.05	.092

purchased significantly less ground beef, pork chops and steaks, and cold meats. But in contrast, they purchased more poultry, ham, and beef roasts. The elasticity coefficients show that an age increase for the head from 40 to 60 years was related to an increase of about one fourth for each of these three meat items.

The regression shows age alone to be a much more significant factor to cold meat consumption than income, size or household composition. A significant relation to education was also found for cold meat.

The use of proportions as the dependent variable showed that pork, poultry, and fish as a proportion of aggregate meat purchases could not be related significantly to any of the socio-economic variables considered. Table 6 shows results only for beef and cold meat. The proportion of cold meat declined with an increase in income and age. Also households containing only adults gave less emphasis proportionally to cold meats. All the declines in cold meat tended to be offset by a corresponding increase in all beef classes except ground beef. Income was related very strongly to beef steak purchases.

Table 7 was produced by using expenditures or value of purchases as the dependent variable. It provides the same information as Table 5 on pounds purchased except that the effect of prices paid is also included in the coefficients.

Table 6. Elasticities[a] describing the relation of selected household characteristics to distribution of quantity of meat purchased, Webster County Survey, June-July, 1963

	Income		Composition		Age of head			
	Elasticity[b]	t value[c]	Coefficient[d]	t value[c]	Elasticity	t value[c]	F	R^2
Beef:								
Ground	-.22	-1.93	-.03	-.26	-.32	-1.98	2.57	.012
Roasts	.36	2.07	-.04	-.23	.63	2.51	3.17	.015
Steak	.80	5.24	.27	1.87	.29	1.32	10.06	.045
Other beef	-.19	-.63	.64	2.29	.25	.56	4.74	.022
Total beef	.17	2.24	.09	1.34	.08	.70	2.43	.011
Cold meat:								
Wieners	-.29	-1.73	-.28	-1.78	-1.05	-4.29	15.41	.068
Other	-.29	-1.77	-.22	-1.44	-.18	-.79	2.26	.011
Total cold meat	-.29	-2.41	-.24	-2.14	-.48	-2.79	9.49	.043

[a]The elasticity describes the proportional change in the proportion of all meats, poultry, and fish accounted for by a particular meat item which can be associated with a proportional change in a socio-economic variable.

[b]Based on a model using log(household income).

[c]t value for regression coefficient used in estimating elasticity.

[d]Magnitude of coefficient represents the proportional adjustment for households containing only adults relative to households containing children.

Table 7. Elasticities of value demanded for selected household characteristics, based on purchases per person, Webster County survey, June-July, 1963

	Income		Composition		Size-household		Age of head			
	Elasticity[a]	t value[b]	Coefficient[c]	t value[b]	Elasticity	t value[b]	Elasticity	t value[b]	F	R^2
Beef:										
Ground	.37	2.76	.37	2.35	-.03	-.24	-.20	-1.16	3.05	.018
Roasts	.89	3.94	.48	1.81	-.36	-2.06	.60	2.08	10.41	.061
Steak	1.44	6.81	.38	1.55	-.65	-3.95	.24	.88	17.23	.097
Other beef	.47	1.84	.55	1.85	-.34	-1.74	.10	.29	5.16	.008
Total beef	.91	6.91	.41	2.68	-.36	-3.54	.17	1.01	19.88	.111
Pork:										
Chops & steak	.27	1.44	.46	2.12	-.21	-1.47	-.42	-1.74	3.36	.021
Bacon	.63	3.95	.46	2.51	-.34	-2.72	.38	1.86	14.73	.086
Ham	.92	3.76	.18	.64	-.22	-1.14	.78	2.48	6.02	.037
Other pork	.55	1.86	.01	-.02	-.69	-3.01	.04	-.09	3.73	.022
Total pork	.60	4.50	.30	1.96	-.32	-3.09	.20	1.19	12.42	.072
Cold meats:										
Wieners	.09	.60	.15	.91	.06	.57	-.75	-3.99	6.34	.038
Other	.10	.75	.03	.19	-.40	-3.76	-.13	-.72	5.67	.034
Total cold meats	.10	.88	.07	.56	-.24	-2.85	-.34	-2.36	3.72	.022

[a] Based on model using log(household income).

[b] t value for regression coefficient used in estimating elasticity tested against zero.

[c] Magnitude of coefficient represents the proportional adjustment for households containing only adults relative to households containing children.

Table 7 (Continued)

	Income		Composition		Size-household		Age of head			
	Elas-ticity[a]	t value[b]	Coeffi-cient[c]	t value[b]	Elas-ticity	t value[b]	Elas-ticity	t value[b]	F	R^2
Poultry	.52	2.89	.39	1.83	-.15	-1.08	.33	1.40	5.78	.035
Fish	.52	2.08	.19	.66	-.42	-2.16	.13	.41	3.42	.021
All meat, poultry & fish	.64	7.16	.32	3.05	-.31	-4.41	.12	1.06	25.84	.140

Since elasticity of value equals elasticity of price paid plus elasticity of quantity purchased[1], the elasticity of prices with respect to each of the socio-economic variables can be obtained by simply subtracting the entries in Table 5 from those of Table 7. Table 8 is the result.

No t test values were determined for Table 8. To provide some measurement of reliability, a regression was completed using the mean price paid by each household for all meat, poultry and fish. Table 9 shows that the four independent socio-economic variables explain a significant part of the variation in price. However, an examination of the t test values shows that household composition had almost no explanatory power if the other socio-economic conditions are held constant.

The results of the special regression on prices for all meats (Table 9) agree very closely with those obtained by subtraction (Table 8). Thus, it is concluded that the elasticity coefficients shown in Table 8 are generally descriptive of the price elasticities for the survey group.

It may be seen in Table 8 that price paid per pound increased with income for all meat items. However, the income effect on price was less than the income effect on quantity for essentially all meat items but cold meat. Price paid per pound

---

[1] $\frac{\partial (pq)}{\partial x} \cdot \frac{x}{pq} = \frac{\partial p}{\partial x} \cdot \frac{x}{p} + \frac{\partial q}{\partial x} \cdot \frac{x}{q}$

Table 8. Elasticities of price[a] for selected household characteristics, Webster County survey, June-July, 1963

	Income	Composition	Size of household[b]	Age of head
Beef:				
Ground	.12	.03	-.05	.15
Roasts	.34	.14	-.08	.06
Steak	.24	.09	-.01	.05
Other beef	.41	-.20	-.14	.09
Total beef	.33	.06	-.10	.13
Pork:				
Chops & steak	.19	-.03	-.07	.05
Bacon	.23	.06	-.06	.18
Ham	.29	.03	.08	.24
Other pork	.25	-.04	-.15	.05
Total pork	.25	.03	-.03	.13
Cold meats				
Wieners	.10	-.06	-.08	.16
Other	.12	.09	-.07	.07
Total cold meats	.11	.03	-.08	.12
Poultry	.11	.01	-.08	-.12
Fish	.17	-.06	-.09	.12
All meat, poultry & fish	.23	.03	-.09	.06

[a]Obtained by subtracting Table 5 from Table 7.

[b]Magnitude of coefficient represents the proportional adjustment for households containing only adults relative to households containing children.

Table 9. Elasticities of price for selected household characteristics for all meats, poultry and fish, Webster County survey, June-July, 1963

	Income		Composition		Size-household		Age of head			
	Elasticity[a]	t value[b]	Coefficient[c]	t value[b]	Elasticity	t value[b]	Elasticity	t value[b]	F	R^2
All meat, poultry & fish	.23	7.73	-.01	-.15	-.12	-5.29	.06	1.48	21.30	.118

[a]Based on model using log(household income).

[b]t value for regression coefficient used in estimating elasticity tested against zero.

[c]Magnitude of coefficient represents the proportional adjustment for households containing only adults relative to households containing children.

increased marginally with the age of the head while larger households paid less per pound.

Comparison to other surveys

Some evaluation of the validity of the coefficients produced herein for Webster County can be obtained by comparing these results to national data. Rockwell (35) used data from the Household Food Consumption Survey of 1955 (46) to produce an income elasticity of quantity of meat, poultry and fish demanded of .29 for medium income households. The corresponding elasticity of demand in terms of expenditures was .31. These coefficients can be compared to the values for Webster County of .41 and .64, respectively. The estimates by Rockwell pertain to all non-farm households in the United States.

Rockwell found beef to be generally more elastic with respect to income than pork. A similar result was obtained for Webster County. The elasticity coefficient concerning household size in Webster County compared closely to the national results.

Engel curves

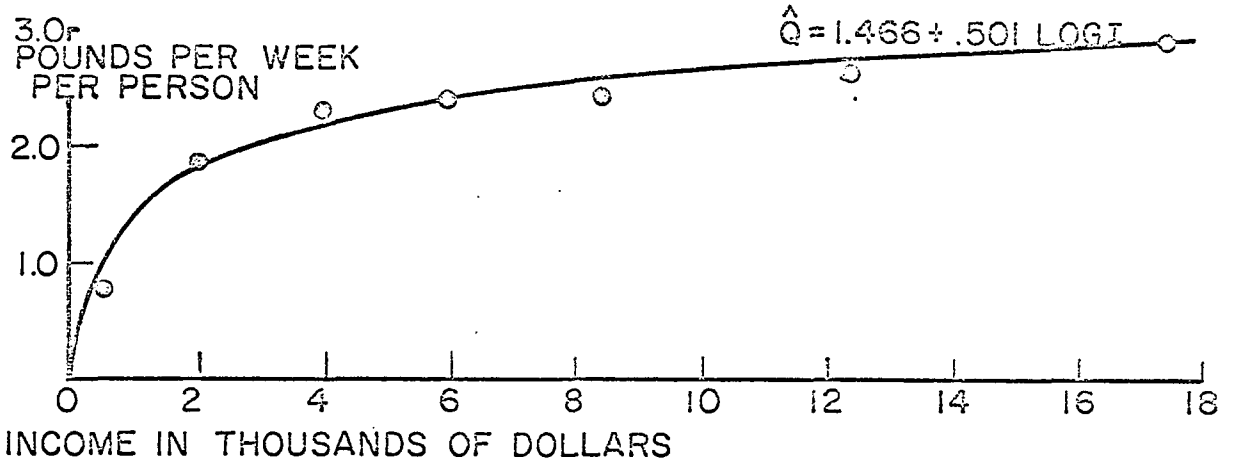
When attempting to project demand for various commodities into the future, economists are particularly concerned about the form of the demand function with respect to income. Many socio-economic variables are relatively stable over time. However, income has generally moved upwards throughout man-

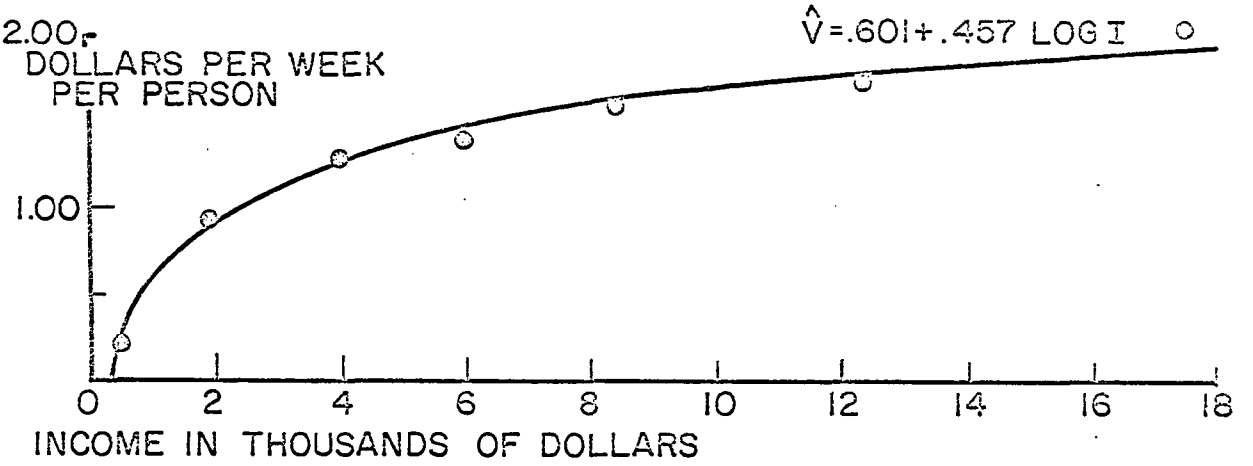
kinds history as a result of increased productive ability. The upward movement soon moves the basis for the projection outside the region of data experience. Thus, a weakness in the form of the function used to make the projection can lead to sizeable errors.

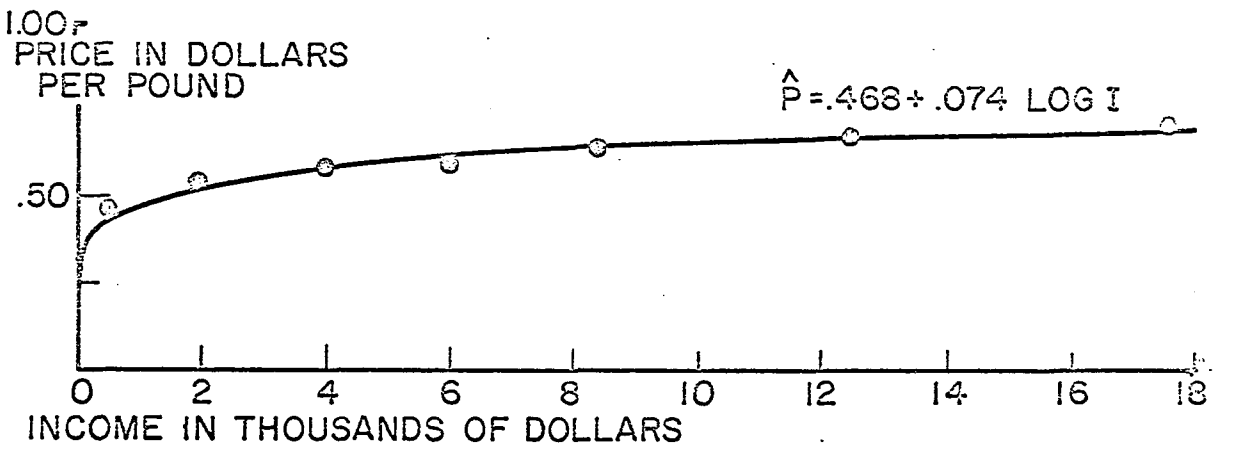
Curves relating demand of a commodity to income are generally called Engel curves. Allan and Bowley (2, p. 7), when completing a comprehensive study of family expenditures in 1935, defined Engel's law with respect to an increase in income as "the expenditures on different items of the budget have changing proportions and that the proportions devoted to the more urgent needs (such as food) decrease while those devoted to luxuries and semi-luxuries increase." Wold (50, p. 323) used nearly the identical definition in Demand Analysis.

The use of the logarithm of income within the model for estimating expenditures on meat fulfills the requirements of the above definitions. While the above definition does not concern either quantity bought or price paid, these measurements of demand, as well as expenditures, are plotted in Figure 6. The data are pounds and dollars per person, and mean price paid for all meat, poultry, and fish. All data have been adjusted for household composition, size of household, and age of household head. The fit appears quite good at both extreme points.

Figure 6. Plottings by income class of observed mean pounds, expenditures and price corrected for household composition, size of household and age of head, Webster County survey, June-July, 1963


3.0
POUNDS PER WEEK
PER PERSON
$\hat{Q}$ = 1.466 + .501 LOG I
2.0
1.0
0
2
4
6
8
10
12
14
16
18
INCOME IN THOUSANDS OF DOLLARS


2.00
DOLLARS PER WEEK
PER PERSON
$\hat{V}$ = .601 + .457 LOG I
1.00
0
2
4
6
8
10
12
14
16
18
INCOME IN THOUSANDS OF DOLLARS


1.00
PRICE IN DOLLARS
PER POUND
$\hat{P}$ = .468 + .074 LOG I
.50
0
2
4
6
8
10
12
14
16
18
INCOME IN THOUSANDS OF DOLLARS

Prais (31) postulated that in addition to the above definition, Engel curves have two properties (a) the existence of an income level below which the commodity is not bought, and (b) the existence of a satiety level providing an upper limit to the quantity bought. From his analysis of household budgets he concluded that the logarithm of income per household member provided a quite satisfactory explanatory variable for both price paid and expenditures per person. However, he formed the Engel curve on quantity by dividing the semi-log representation for price into that for expenditures. This gives

$$q = \frac{v}{p}$$

$$= \frac{a + b \log I}{c + d \log I} \qquad (21)$$

where

q = quantity per person,

v = expenditure per person,

p = mean price paid,

and

I = income per person.

Such a representation possesses an upper limit equal to b/d.

The survey data on quantity per person have been plotted against income using this representation in Figure 7. Adjustments have been made for household composition, size, and age of household head. Visual examination of both Figures 6 and 7 shows one form to be about as reasonable as the other.

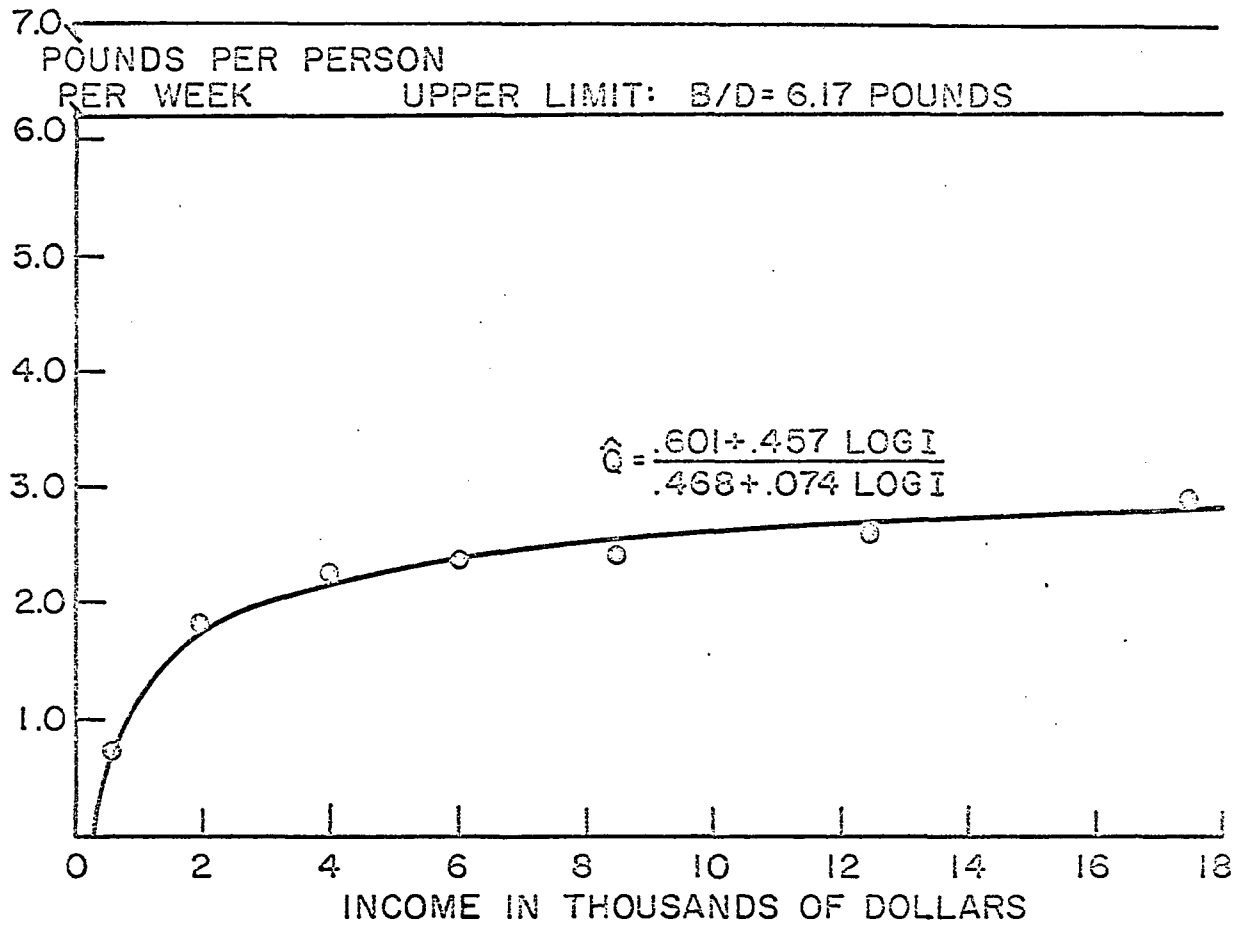


Figure 7. Plotting by income class of observed mean pounds per person corrected for household composition, size of household and age of head, Webster County survey, June-July, 1963

Residual variation was actually a little less for the latter, but most of the difference was associated with the better fit achieved for the lowest income group when using equation 21.

Figure 7 shows the upper limit to be 6.17 pounds per person per week. No data are known to be available to which this value can be compared for reasonableness. The convergence rate is such that the income value must be greater than twice the range of income values obtained in the survey before a rate of 4 pounds per week is exceeded.

This limit, of course, does not apply to an individual household. Rather, it represents a value to which the mean for a group of households can be compared. Individual households within the survey group exceeded the limit; 6.17 pounds represents a span of 2.35 standard deviations from the survey group mean in terms of variation among individual households.

EFFECTS OF PRICE AND NON-PRICE OFFER VARIATION UPON DEMAND

Emphasis was given earlier to the influence upon demand of the individual characteristics of the household. Attention will now be turned to the other variables within the demand function, price p and non-price offer variation a. Nevertheless, the socio-economic variables within the demand function will not be ignored for this analysis. The possibility of each of the above variables having a different effect upon demand for different socio-economic groups will be considered. The variables of concern are of considerable interest to marketers for they are variables over which they have some degree of control. Possible influences of advertising and promotion upon certain groups of people are especially pertinent. Marketers acknowledge a lack of strong control on pricing in general, but nevertheless, they recognize their role in the price offer-acceptance process. Attempts at product differentiation are often aimed at increasing the control over marketing variables.

The method of analysis used is that of regression upon time series data. In order to relate demand to say, price, it is necessary to examine the changes in purchasing corresponding to changes in prices. However, the prices within the economic system of interest herein cannot be manipulated at will by the experimenter. Rather, the researcher must let

economic forces manipulate the prices; the researcher studies the effects by time series data.

Concentration will be given first to developing the needed time series from the data collected on consumers and retailers over a seven week period. Interest will next be turned to using these time series within a regression model to approximate the demand function. Finally, the results of the regression runs will be interpreted.

Data Series

Meat classification

A meat classification scheme involving 135 classes was initially used to classify the 7,067 individual purchases made by the consumer panel during the second through fourth weeks of interview. This original grouping was reduced to 18 for the cross-classification tables used to study socio-economic factors. A further reduction to 12 classes seemed appropriate for the earlier regression analysis. However, this classification scheme was not considered entirely appropriate for investigating the effects on demand of price and non-price offer variation. To quantify the effects of these factors on demand, it is necessary to follow a grouping for which all individual kinds of meat within a group tend to follow a similar pattern of price and offer fluctuation.

Table 21 in Appendix C shows the thirteen classes finally

selected. In forming these thirteen classes emphasis was given to the physical homogeneity of the various cuts in each class and to price variation within the sample data. Newspaper advertisements were examined to determine the groupings used.

An attempt was made to formulate a high-value and low-value variant whenever possible. It was noted in the newspaper advertising examined that the lower priced variant within any particular kind of meat class was advertised much more often.

Of course, attention was also given to the aggregate size of any class. As will be noted later, division of the 7,067 observations on the basis of time, retail store, socio-economic classification, and kind of meat can lead to analytical units containing very few observations.

Not all meat items were included within the thirteen classes formed. It was deemed preferable to conduct the analysis upon classes of meat satisfying a minimum level of homogeneity, rather than to attempt to include all meat purchases. The thirteen meat classes accounted for 87 percent of all beef purchases, 55 percent of all pork, 62 percent of all cold meat, and 88 percent of all poultry. From an overall standpoint, about 75 percent of all meat and poultry were included.

The smallest two groups within the thirteen groups in-

cluded 119 and 133 individual purchases. However, the overall average was 341 purchases.

Store classification

The survey group purchased meat from 68 retailers in all. However, the largest eight of the local retailers accounted for nearly three fourths of all purchases. Only 5 percent of the total purchased were made outside of Webster County.

An examination of weekly data compiled for the eight survey stores on pricing, advertising, and in-store-promotion could not establish that the stores were following any common pricing pattern. A similarity in price fluctuations was noted only for two pairs of two stores, each pair of which belonged to the same chain and used common newspaper advertisements.

The lack of similarity of pricing and advertising on the part of the retailers suggested that the stores from which the panel purchased be divided into five groups. Two of the five contained a single retailer; another consisted of a large and small member of a chain who cooperated on advertising and promotion. The fourth group consisted of the other four stores for which survey data were collected; these four stores were all relatively small. The fifth store group contained all other stores from whom panel member purchased both within and outside Webster County.

The overall effect of this grouping was to divide the

purchases into five groups of approximately equal size for which pricing, advertising, and promotion practices were similar. The largest store group accounted for 25 percent of the total purchases while the smallest contributed 17 percent. From hereon the word "store" will refer to one of these store groups.

Selection of time span increments

The diaries used by the household panel pertained to weeks starting on Wednesday morning and ending the following Tuesday evening. This period was selected when organizing the study because it appeared to correspond with a natural shopping and consumption cycle. Also, a questioning of store operators indicated that new prices were often established Wednesday for the following week. Nevertheless, the specific date of purchase was recorded in the diaries in case another accounting period should be preferred during analysis.

An examination of newspaper advertisements showed that the larger retailers quite consistently followed the pattern of a full page ad on Wednesday and a one fourth to one half page ad on Monday. Prices for the Wednesday ad became effective either immediately or the following day and remained in effect through Saturday. The Monday ad prices were usually effective Monday through Wednesday. It was found that an advertised price was very seldom effective through out the entire week.

Because of the advertising pattern noted, the possibility of using a bi-weekly time series increment was given some consideration initially. An attempt was made to determine the existence of within week price adjustment patterns for some of the meat groups at the larger stores. However, no within week pattern could be established. Moreover, it was not possible to obtain a clear-cut relation between the prices listed in the newspaper ads and the prices which the consumers reported they paid. Even though a total of 7,067 purchases were made during the seven week study period, the number of purchases of a particular advertised meat item during the span of the ad was extremely small.

In consequence of the apparent absense of any meaningful within week price adjustment pattern, it was decided to use the entire week as the time span increment. The Wednesday through the following Tuesday period selected initially was followed. Such an increment not only simplified data processing, but it also doubled the number of observations available to describe activity in each time increment.

Determination of price indexes

Price data were available for use in the analysis from four different sources. An interviewer-observer collected price data for twenty three choice grade standard meat cuts on either Monday or Tuesday from the eight largest stores in the county. An observer obtained data on all items being

given special promotion by visiting the stores either Thursday or Friday; the price of special offers of meat were recorded. Most newspaper advertising contained offer prices. And finally, the respondents recorded the price they paid for all items.

The price data collected on the twenty three standard cuts failed to reflect a major share of the price reductions since most of the price reductions pertained to the latter half of each week. This problem could have been overcome partially by use of the prices noted in advertisements and promotion material. However, a substantial weighting problem still remained. For example, price data were needed for the general group, chuck roasts. But, data were collected from the store only on choice grade arm cuts. Stores offered several cuts of chuck in both good and choice grades. Newspaper ads usually pertained to the lower priced cuts rather than to the arm cut.

It was deemed most suitable to use the prices recorded by the consumers to develop the price indexes. A self-weighting characteristic of these data constituted a major advantage. The use of weekly data on expenditures and quantity purchased by all households at a particular store to determine the weekly price for a class of meat, self-weighted the prices for the many individual cuts going into the class. Price alterations within the week were also self-weighting.

However, a weekly price series obtained by this method portrays only the mean prices paid by purchasers. The series may not always reflect adjustments in prices offered by the retailer. That is, if the survey group tended to concentrate on the low priced cuts in a particular meat class one week and the high priced cuts another week, a decreased price would be recorded for the first week and a higher price for the second week even though the price offering remained constant for both weeks.

In summary, the price index used for each of the five-store groups for ten of the thirteen classes of meat were obtained by aggregating purchases of all members of the panel. Price was taken as amount paid divided by quantity. For the two classes of beef steaks and the lower quality pork chops and steak class, an exception was made. Each of these three classes were again divided into two quality levels. A price index was then computed for each of the six. These indexes were then aggregated by using weights derived for each store by use of all purchases within the seven week period.

Figure 8, showing prices and quantity of cut-up frying chicken purchased per week, presents an example of the data series used. The reader should note the rather sizeable amount of variation in both price and quantity from week to week. Yet despite that variation the tendency for a low price to be associated with high quantity can be seen. The

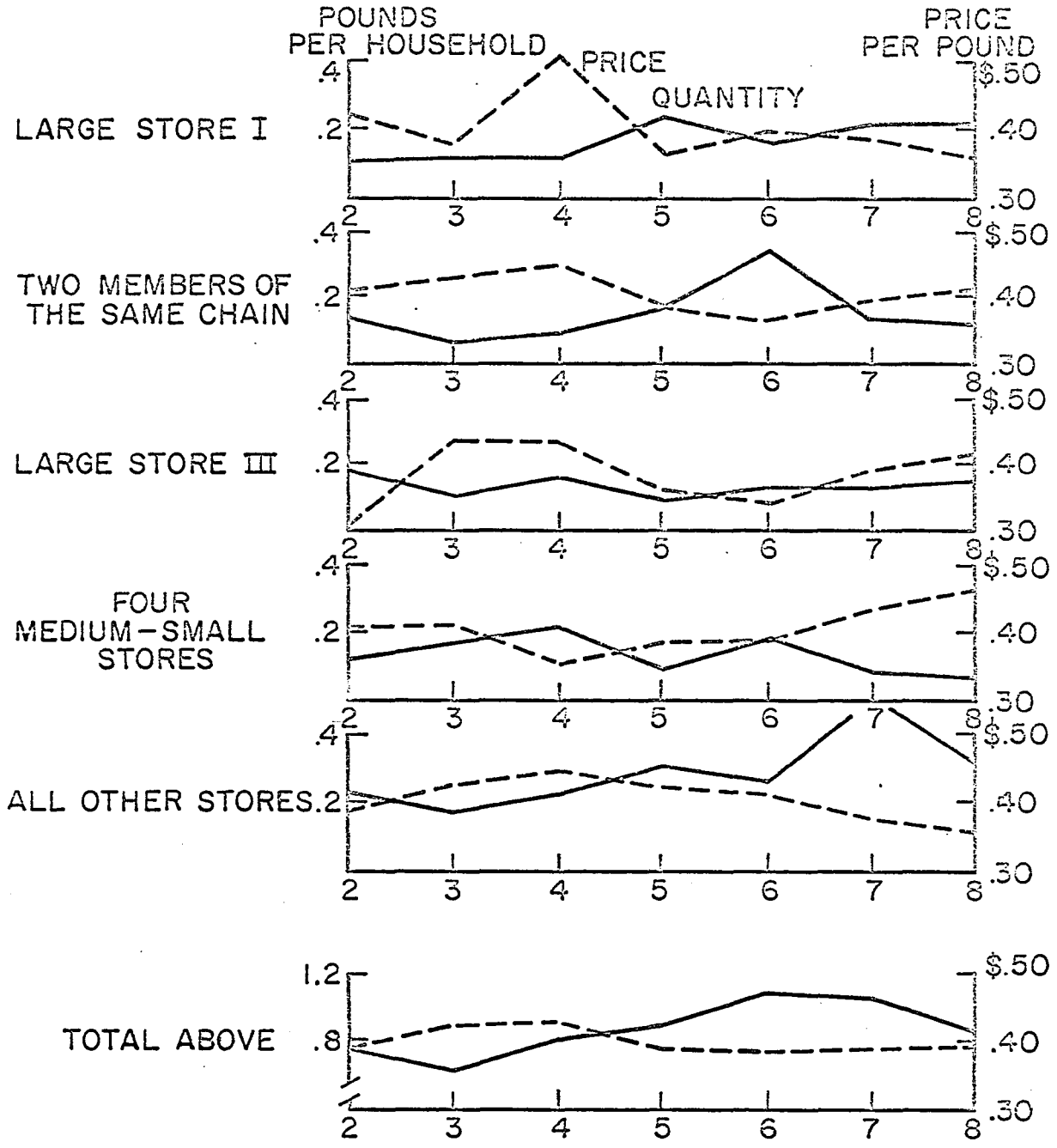


Figure 8. Price and quantity data for cut-up fryers by store by week, Webster County survey, June-July, 1963

series for cut up chicken was one of the more uniform series. Other meat classes, for which purchasing was less frequent and greater product variation was inherent, possessed greater variation relatively.

Indexes for non-price offer variation

Data were collected on nearly all forms of advertising and promotion used by the eight stores making up the first four store groups during the survey period. All newspaper advertisements used were clipped. An observer-interviewer visited the stores weekly to record data on the size of promotional signs, the message of the sign, special displays, and price reductions for all grocery products.

Most of the newspaper advertising was oriented toward an announcement of prices for various items. Variation occurred in format and amount of space given to each item listed, but the overall ad size remained nearly constant from week to week. The predominant pattern was a full page ad on Wednesday giving prices effective through Saturday and a one fourth to one half page ad on Monday giving prices effective through Wednesday.

The greatest variation in advertising appeared to be whether a meat item was listed and secondly, to the amount of space given to the listing. The amount of space given to meats altogether varied considerably more from week to week than did the total amount of ad space.

To represent the advertising aspect of non-price offer variation, indexes based simply upon ad space were constructed for each of the thirteen meat groups. The aggregative effect of all advertising was treated by summing the individual indexes.

A space type of index was also used to indicate in-store promotion. In this case, space consisted of the area of in-door promotional signs. A somewhat arbitrary adjustment was made for infrequent occurrences. For example, one store often used rather large front window signs for special announcements. The "space" within the index assigned to this media was recorded as twice the mean size of the signs directed to indoor traffic. One store offered free cooked samples of a brand of wieners being promoted one week-end; this promotional means was arbitrarily taken to be equivalent to three average indoor signs.

Mean sales volume was used as a weight when combining the indexes for the separate stores into the store groups used in the analysis. Both the advertising and in-store promotion index for the fifth store group were considered to be zero in all cases. The use of zero level here is quite realistic since these small stores conducted a negligible amount of newspaper advertising. Data on in-store promotion for these small stores was not available.

A summary of in-store promotion and advertising over the

survey period is shown for the thirteen meat classes in Figure 9. The concentration given to hamburger, chuck roasts, lower quality beef steaks, and wieners stands out clearly.

Formation of socio-economic groups

It was suggested at the beginning that households having different socio-economic characteristics may not react in the same way to fluctuations in price and non-price offer variation. To investigate this possibility, it is necessary to approximate the relationships between price and demand for households having a certain set of characteristics and then to compare that relationship to one determined for households having a different set of characteristics.

The six socio-economic characteristics considered earlier when analyzing the direct effect of such factors on demand served as a starting point here. However, the volume of data collected in the survey was too small for each of these characteristics to be considered directly in the current analysis. As an alternative, the households were divided into seven nearly equal sized groups possessing somewhat similar characteristics as a proxy for all socio-economic attributes.

The final classification was based upon both income and family composition. The division by family composition produced a classification having some correspondence to both family size and age of household head. Income served to separate effectively the households by education. Figure 10

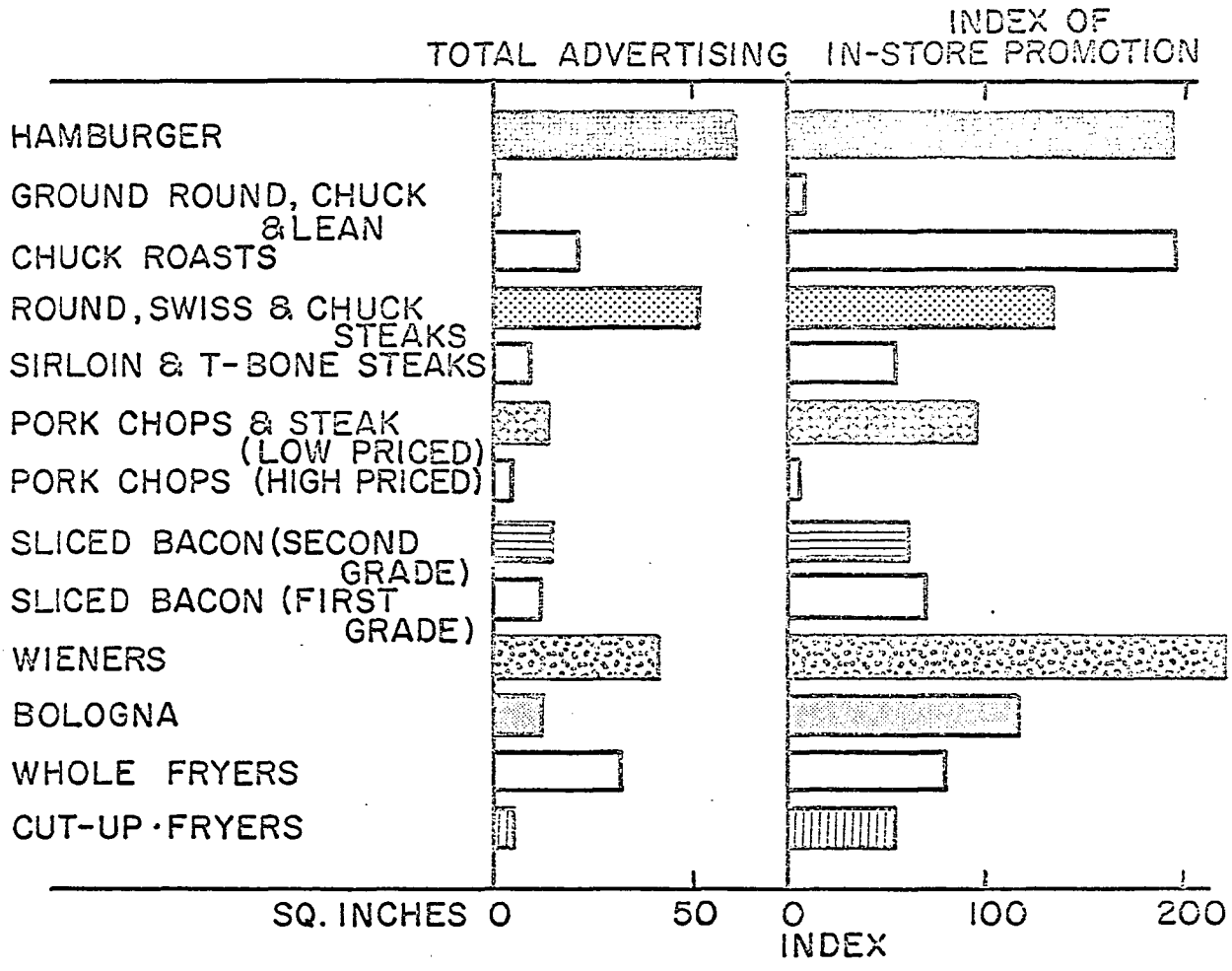


Figure 9. Newspaper advertising and index of in-store promotion for selected meats by eight retailers, Webster County survey, June-July, 1963

	Household Income			
	$2,999 or less	$3,000 to 4,999	$5,000 to 6,999	$7,000 & over
Adults only or adults with all children over 12 years	Group #1 90	Group #3 79	Group #5 68	Group #7 109
Household contains children 12 years or less	Group #2 85		Group #4 102	Group #6 109

Figure 10. Number of survey households in each socio-economic group, Webster County survey, June-July, 1964

shows the number of households in each group and the basis of division. Mean values for data on various socio-economic attributes are contained in Table 10. The socio-economic classification on household composition is slightly different than used in the last chapter; the adult type households for the current grouping also includes households for which all children are over 12 years of age. This alteration made the groups more equal in size.

Table 10. Characteristics of socio-economic groups, Webster County survey, June-July, 1963

	Socio-economic group						
	1	2	3	4	5	6	7
Mean number of persons in household	1.68	4.73	2.15	5.09	2.38	4.90	2.55
Mean income ($1,000)	1.58	3.68	4.00	6.00	6.00	10.49	10.60
Mean age of head	70.52	37.70	57.76	36.59	55.91	39.11	53.84
Mean educational attainment of head	8.77	10.81	10.61	11.49	10.56	12.97	11.36

Data series in summary

In all, four data series were constructed. These were (1) quantity, (2) price, (3) advertising, and (4) in-store promotion. Each of these concern thirteen meats purchased at five store groups within seven weeks. The quantity data were also divided into purchases by seven socio-economic groups. In consequence, 455 measurements were constructed for price, advertising, and promotion, while seven times 455 or 3185 observations were developed for quantity.

Discussion of the details involved in forming the quantity series has been included after the presentation of the initial model used for the analysis; symbols pertinent to a clear description of the series are defined when developing the model. For the interim it need only be asserted that this series involved 3185 quantity means.

Model Development

Additive model

The first model fitted to the time series data was:

$$
\begin{aligned}
y_{mijt} = {} & (\alpha+\alpha_m+\alpha_j)u_{mit}+(\beta+\beta_m+\beta_j)v_{mit}+(\gamma+\gamma_m+\gamma_j)w_{mit} \\
& + \alpha^{(1)}u^{(i)}_{m\cdot t}+\alpha^{(2)}u^{(m)}_{\cdot it}+\alpha^{(3)}u^{(i)}_{\cdot\cdot t} \\
& + \beta^{(1)}v^{(i)}_{m\cdot t}+\beta^{(2)}v^{(m)}_{\cdot it}+\beta^{(3)}v^{(i)}_{\cdot\cdot t} \\
& + \gamma^{(1)}w^{(i)}_{m\cdot t}+\gamma^{(2)}w^{(m)}_{\cdot it}+\gamma^{(3)}w^{(i)}_{\cdot\cdot t}+e_{mijt}\,, \qquad (22)
\end{aligned}
$$

where

$m=1,2,\ldots,13$ (meat class index),

$i=1,2,\ldots,5$ (store group index),

and $j=1,2,\ldots,7$ (socio-economic group index),

$t=1,2,\ldots,7$ (survey week index).

The parameters are defined in a general sense to be

γ = price elasticity of demand,

β = advertising elasticity of demand,

and

γ = in-store promotion elasticity of demand.

Writing the time series data as

q_{mijt} = quantity per person[1],

p_{mit} = price,

b_{mit} = advertising,

and

c_{mit} = in-store promotion,

the main variables used in the model are

$$y_{mijt} = \frac{(q_{mijt} - q_{mij\cdot})}{q_{mij\cdot}} ,$$

$$u_{mit} = \frac{(p_{mit} - p_{mi\cdot})}{p_{mi\cdot}} ,$$

$$v_{mit} = \frac{(b_{mit} - b_{mi\cdot})}{b_{mi\cdot}} ,$$

and

$$w_{mit} = \frac{(c_{mit} - c_{mi\cdot})}{c_{mi\cdot}} ,$$

where the use of a dot in the position of a subscript denotes the taking of an arithmetic mean over that classification. The variables concerning price in the second line of 22 are defined as

---

[1]The next section gives a specific definition.

$$u^{(i)}_{m\cdot t} = \frac{\frac{5p_{m\cdot t} - p_{mit}}{4} - \frac{5p_{m\cdot\cdot} - p_{mi\cdot}}{4}}{\frac{5p_{m\cdot\cdot} - p_{mi\cdot}}{4}} ,$$

$$u^{(m)}_{\cdot it} = \frac{\frac{13p_{\cdot it} - p_{mit}}{12} - \frac{13p_{\cdot i\cdot} - p_{mi\cdot}}{12}}{\frac{13p_{\cdot i\cdot} - p_{mi\cdot}}{12}} ,$$

and

$$u^{(i)}_{\cdot\cdot t} = \frac{\frac{5p_{\cdot\cdot t} - p_{\cdot it}}{4} - \frac{5p_{\cdot\cdot\cdot} - p_{\cdot i\cdot}}{4}}{\frac{5p_{\cdot\cdot\cdot} - p_{\cdot i\cdot}}{4}} .$$

The variables in the third and fourth lines are defined similarly. Variable e_{mijt} is a stochastic disturbance term.

A major reason for transforming all time series data to proportional deviations was to remove main effects of meat classes, store groups, and socio-economic classes. As may be noted by examining the form of transformed time series given above, a segment of any series corresponding to a given meat m and store i sums to zero over the time index. The quantity series also sums to zero over time for a given socio-economic group j. The removal of main effects enabled a more simplified model to be used. It was not necessary to explain the general magnitude of variables by the model, but only necessary to explain displacement of the variables over time.

The use of proportions, rather than only deviations in re-

moving the main effects, placed the data on a unit free basis. It was hypothesized in constructing the model that the relations envisioned would be more stable with respect to proportional displacements. An added advantage of using proportions is that the desired elasticity coefficients at the data means are parameters of the linear model.

The magnitude of the effects being removed can perhaps best be obtained by examining Table 21. The quantity of purchases of some of the larger meat classes was nearly ten times as large as that of the smaller classes. The price difference between t-bone steak and whole fryers was substantial. Figure 9 shows that some meats are advertised much more frequently than others. While q_{mijt} referred to quantity per week per person, it was determined earlier that this amount varied significantly among households having different socio-economic characteristics.

The variables defined as $u^{(i)}_{m\cdot t}$, $u^{(m)}_{\cdot it}$, and $u^{(i)}_{\cdot\cdot t}$ for price, and the similar variables for advertising and in-store promotion, were intended to place the elasticity coefficients on what might be called a ceteris paribus basis. The first, $u^{(i)}_{m\cdot t}$ is an index for fluctuation in price of meat m at stores other than i. The variable $u^{(m)}_{\cdot it}$ is an index of all meat prices other than meat m at store i. Variable $u^{(i)}_{\cdot\cdot t}$ is an index of all meat prices at all stores other than store i.

The use of these variables was based on the assumption

that a shopper's decision to patronize a particular store at a particular time would be influenced by prices, advertising, and in-store promotion for all meat product products in general. Once the shopper entered the store, it was expected that she would again be influenced by the price of a particular meat relative to all meats. The expressions "composite variables" and "composite parameters" will be used henceforth to denote this part of the model.

Estimation of error variance

The term e_{mijt} was defined earlier to be a stochastic disturbance term. It reflects the failure of the explanatory variables to account fully for the variation in y_{mijt}. The disturbance may be divided into two components, $e^{(1)}_{mijt}$ and $e^{(2)}_{mijt}$ where

$$e_{mijt} = e^{(1)}_{mijt} + e^{(2)}_{mijt} . \qquad (23)$$

The component $e^{(1)}_{mijt}$ denotes the error corresponding to the failure of the particular explanatory variables used and the form in which they enter the model to portray fully the effect of price and non-price offer variation upon consumer purchases. The component $e^{(2)}_{mijt}$ accounts for the failure of similar groups of consumers to respond alike when confronted by the same retail market situations. That is, the first component concerns an error in determining the effect of the market variables on demand while the second pertains to the unpredictableness of people.

The goal in constructing the model described by 22 was of course to make $e^{(1)}_{mijt}$ as small as possible. But many other model forms and explanatory variables could have been used. For example, seasonal or perhaps monthly market variation patterns were not considered in the model.

The variance pertaining to the total disturbance term e_{mijt} can be estimated by the mean square of the residuals from regression. The technique used to estimate the variance associated with the second term, called simply error variance from hereon, is now discussed.

The households assigned to each of the seven socio-economic groups within each panel segment (see Table 1) were divided randomly. This division adds another classification index to those mentioned above. Consequently, the 3185 groups of observations become twice this number or 6370. This index is called s and s=1,2.

The mean quantity of purchases of meat m at store i during week t by householders in the panel during week t and in socio-economic group j and sample split s, can be defined as q_{mijts}. The variable y_{mijts} can be defined as

$$y_{mijts} = \frac{q_{mijts} - q_{mij\cdot\cdot}}{q_{mij\cdot\cdot}} \qquad (24)$$

and the variable q_{mijt} used in 22 as

$$q_{mijt} = q_{mijt\cdot} \qquad (25)$$

where the dot in the subscript implies an unweighted arithmetic

mean. Since the random split supplied an approximately equal division in number of households assigned to any socio-economic group by week, the quantity mean q_{mijt} approaches closely an arithmetic mean of the purchases involved.

These definitions, of course, lead also to

$$y_{mijt} = y_{mijt}. \qquad (26)$$

where y_{mijt} has the earlier definition. Under the assumption that the socio-economic classification used herein explains all differences in purchasing due to differences between households, both variables y_{mijt1} and y_{mijt2} are unbiased estimates of the same parametric value. Thus, the two sample values can be used to form a one degree of freedom estimate of error variance. Using all 3185 pairs gives an estimate based on that number of degrees of freedom. This technique was used to produce the mean square estimate of 1.63 shown in Table 12.

Results from fitting additive model 22

Tables 11 and 12 summarize the results of fitting the data to the model defined in equation 22. Table 11 presents estimates of selected parameters. Fitting the model in various stages supplied the analysis of variance in Table 12.

The estimate of error variance supplied by the random split of the survey group was 1.63 while the residual mean square was 1.56. The hypothesis of a zero value of variance associated with error in determination of model structure and

market variation variables is not rejected at the .05 significance level.

The F values associated with fitting all parameters in the model and the various groupings of parameters presented in Table 12 were all statistically significant at the .05 level. However, the F value associated with both all meat class interactions ($\hat{\alpha}_m, \hat{\beta}_m, \hat{\gamma}_m$) and fitting all parameters for in-store promotion, subject to fitting all other parameters, surpassed the .05 level by only a small margin.

The coefficients in Table 11 were examined for possible conformity to hypothesis suggested by the characteristics of the individual meat classes and socio-economic groups. It was noted that the lower qualtiy meat variants appeared to be generally more elastic with respect to price than were the higher quality variants. Price elasticities became less elastic as income increased and households having children were associated with greater price elasticity than other households. An examination of the interaction coefficients for advertising and in-store promotion for conformity to such hypotheses failed to suggest any potential relationships.

Advertising and in-store promotion, as well as pricing behavior were noted earlier to be correlated. In addition it was noted that certain meats were advertised and received in-store promotion much more often. This suggested a possible relationship among price, advertising, and promotion elasti-

Table 11. Elasticities of quantity demanded for price, advertising, and promotion obtained by use of additive model in equation 22, Webster County survey, June-July, 1963

	Elasticities		
	Price	Advertising	In-store promotion
Overall $(\hat{\alpha},\hat{\beta},\hat{\gamma})$	-1.015	.064	.007
By meat $(\hat{\alpha}+\hat{\alpha}_m,\hat{\beta}+\hat{\beta}_m,\hat{\gamma}+\hat{\gamma}_m)$:			
Beef:			
Hamburger	-1.971	.127	-.013
Ground round, chuck, and lean	-.983	-.081	-.087
Chuck roast	.478	.299	-.080
Round, swiss, chuck, cube steak	-2.939	-.053	-.010
Sirloin and t-bone steak	-.523	.035	.059
Pork:			
Steaks and end-cut chops	-.800	-.109	.244
Chops - center cut	-.380	.101	-.236
Bacon-second grade	-1.394	.099	-.010
Bacon-first grade	-1.045	.102	.003
Cold meat:			
Wieners	-1.883	.113	-.093
Balogna	.596	.128	.100
Poultry:			
Whole fryers	-1.144	.086	.047
Cut-up fryers	-1.206	-.011	.168
By socio-economic group $(\hat{\alpha}+\hat{\alpha}_j,\hat{\beta}+\hat{\beta}_j,\hat{\gamma}+\hat{\gamma}_j)$:			
Group: 1	-.620	-.006	.049
2	-2.278	.232	-.033
3	-2.365	.041	-.100
4	-1.392	.028	.049
5	-.846	.006	.039
6	.488	.090	.038
7	-.092	.058	.007

Table 12. Analysis of variance for selected explanatory variables of model in equation 22, Webster County survey, June-July, 1963

Source of variation	Degrees of freedom	Mean square	F value
With respect to main effects and interactions:			
Overall elasticities ($\hat{\alpha},\hat{\beta},\hat{\gamma}$ and composite variables)	12	8.54	5.24
Meat classes ($\hat{\alpha}_m,\hat{\beta}_m,\hat{\gamma}_m$ | all others)	36	3.82	2.34
Socio-economic classes ($\hat{\alpha}_j,\hat{\beta}_j,\hat{\gamma}_j$ | all others)	18	2.45	1.50
With respect to price, advertising, and promotions			
Price ($\hat{\alpha},\hat{\alpha}_m,\hat{\alpha}_j$ and price composite | all others)	22	3.13	1.92
Advertising ($\hat{\beta},\hat{\beta}_m,\hat{\beta}_j$ and advertising composite | all others)	22	4.11	2.52
In-store promotion ($\hat{\gamma},\hat{\gamma}_m,\hat{\gamma}_j$ and promotion composite | all others)	22	2.72	1.67
All explanatory variables	66	3.88	2.38
Residual	2,664	1.56	.97
Error	3,185	1.63	

cities for individual meat classes. Again however, the estimates failed to offer evidence to support any hypothesis conceived by the author of this form.

All three main effect elasticity estimates were judged to be of correct sign. In the theory section, it was hypothesized that price and quantity are related negatively subject to the condition that income is adjusted so that the person remains on the same indifference surface. But it was found earlier that

the income elasticity of demand was generally positive for meats. Thus, the income effect and the substitution effect (inequality 9) are in the same direction and the hypothesis proposed here is that price elasticities of demand for meat are negative.

One may assume that store operators possess a reasonable degree of skill in advertising and promotion such that an increase in these activities leads to an increase in quantity sold. Upon this basis, the signs for the advertising and in-store promotion are hypothesized to be positive.

Returning to the coefficients for interaction, it may be noted that most of the price elasticities were negative in Table 11. However, when forming elasticities for prices which take into account additively both a meat class and socio-economic group effect (i.e. $\hat{\alpha}+\hat{\alpha}_m+\hat{\alpha}_j$), many of these possessed a positive sign. Many of the coefficients for advertising and in-store promotion failed to be in agreement with the hypothesis of a positive sign.

The above reasoning suggested that the terms associated with the interactions of both advertising and promotion with meat classes and socio-economic groups (i.e. $\beta_m, \beta_j, \gamma_m, \gamma_j$) be eliminated when conducting further analysis. The reasoning was not based upon the overall statistical significance of the interaction components; an F value of 2.06 was determined for these components subject to fitting all other parameters (36

degrees of freedom in numerator). Rather, the reasoning was based upon non-conformity, to any of several hypotheses associated with the factors of interest in this study.

Further regressions completed for a model similar to 22, but with the above interaction terms removed, suggested the price by meat interaction term (β_m) be eliminated by reason of statistical non-significance. However, this component was retained when conducting the analysis for serial correlation in the following section.

Serial correlation of the quantity data series

The overlapping of the time periods in which households were included in the survey presented a potential problem of serial correlation. The reader may note by examining Table 1 that the survey was designed originally to have a constant overlap of three-fourths for all contiguous weeks and for the first and final weeks. Disregarding the data for the initial interview altered the overlap in an asymetric manner.

Serial correlation of data need only be considered when the disturbance term becomes serially correlated. Classical regression procedures still produce unbiased estimates of the parameters in a linear model. But the efficiency of estimation is reduced. Taking the correlation into account can make worthwhile reductions in variance. Thus, an estimate of the serial correlation caused by sample overlap was desired.

The relationship between residuals, z_{mijt} resulting from

sample overlap can be expressed by the model

$$z_{mijt} = \rho^*(r_t^{(1)} z_{mijt-1} + r_t^{(2)} z_{mijt-2}) + e_{mijt} \qquad (27)$$

where $r_t^{(1)}$ is the ratio of twice the number of survey segments common to both weeks t and t-1 relative to the sum of the segments interviewed in weeks t and t-1. Of course data corresponding to the first week of interview is neglected. As an example of the computation, $r_3^{(1)}$ equals two thirds since two segments are common to weeks two and three and a total of three segments were interviewed each week (see Table 1). The coefficient $r_t^{(2)}$ is defined similarly, but in this case the link is to t-2. The sampling scheme is circular since the first week of interview is linked by common segments to the final week.

The parameter ρ is defined to be the correlation between quantity of purchases of meat m at store i by household h at time t with the quantity of purchases of the same meat at the same store at time t' where t' equals t-1 or t-2. That is, the correlation in purchases is assumed to be the same when spanning either one or two weeks and for all meats, stores, and households. No serial correlation within the time series corresponds to a zero value for ρ.

However, the dependent variable y_{mijt} for the regression was formed by subtracting the mean quantity purchased over the seven week period from the weekly quantity data. Hence, if

the q_{mijt} are uncorrelated for any given mij, the corresponding y_{mijt} are correlated negatively one-seventh. The value for ρ^* in the model corresponding to no serial correlation in the original series is minus one-seventh.

A regression on the residuals obtained by fitting an abbreviated form of model 22 (i.e. without $\beta_m, \beta_j, \gamma_m, \gamma_j$) provided an estimate of ρ^* of -.23. Testing this value against the hypothesized value of -.12 gives a t statistic[1] of -4.58 which is significant at the .05 level. It appears that the correlation of the original series was about -.11.

Although ρ was declared significantly different from zero, no attempt was made to remove the serial correlation from the time series. Removal of the correlation would have reduced the variance of the residuals by about $(1-\rho^2)$ or an estimated one percent (25, p. 178). Hence, the gain of efficiency from the transformation of the data did not appear to justify the cost.

Check on homogeneity of error variance

The error variance estimates obtained by splitting the quantity data series at random served another purpose. It provided an estimate of error variance for purchases of each kind of meat by each socio-economic group.

As may be noted by examining the procedure used to get the overall error variance estimate, the 3185 values in the time

[1]The test statistic is only approximately distributed as Student's t.

series data on quantity were obtained by use of 3185 pairs of values. Each pair supplied a one degree of freedom estimate of error variance. These 3185 pairs can be grouped by meat class and socio-economic group. These thirteen times seven or 91 subgroup contain 35 pairs of values which can be used to form 35 degrees of freedom estimates of error variance. Each estimate pertains to a specific meat and economic subgroup.

A Bartlett's test for homogeneity of variance was applied to these estimates. It produced a χ^2 value which was highly significantly and the hypothesis of homogeneity of variance for all meat classes and all socio-economic groups was rejected.

All regressions discussed from here on were completed after weighting the observation data by the inverses of the estimated standard errors for meat by socio-economic groups. The analysis of variance tables to follow have been scaled such that residual mean square after using the weights equals the error variance estimate of 1.63 shown in Table 12.

Results of fitting an abbreviated additive model

The elasticity estimates obtained by fitting a model corresponding to equation 22, but without the interaction terms for advertising and in-store promotion with meat and socio-economic classes ($\beta_m, \beta_j, \gamma_m, \gamma_j$), are presented in Table 13. The corresponding analysis of variance is given in Table 14. All observations were weighted inversely by the

Table 13. Elasticities of quantity demanded for price, advertising and in-store promotion obtained by abbreviated additive model[a], Webster County survey, June-July, 1963

	Elasticity	t value
Price ($\hat{\alpha}$)	-1.335	-4.96
Advertising ($\hat{\beta}$)	.043	2.59
In-store promotion ($\hat{\gamma}$)	.024	1.44
Price by meat ($\hat{\alpha}+\hat{\alpha}_m$):		
Beef:		
Hamburger	-1.613	
Ground round, chuck, and lean	-.701	
Chuck roast	-1.686	
Round, swiss, chuck, cube steak	-2.843	
Sirloin and t-bone steak	-.224	
Pork:		
Steaks and end-cut chops	-1.516	
Chops-center cut	-.809	
Bacon-second grade	-1.130	
Bacon-first grade	-1.733	
Cold meat:		
Wieners	-1.951	
Balogna	-.536	
Poultry:		
Whole fryers	-1.387	
Cut-up fryers	-1.226	
Price by socio-economic group ($\hat{\alpha}+\hat{\alpha}_j$):		
Group: 1	-1.392	
2	-2.749	
3	-2.528	
4	-1.525	
5	-.851	
6	-.596	
7	.296	

[a]Additive model in equation 22, excluding $\beta_m, \beta_j, \gamma_m, \gamma_j$, was used.

Table 14. Analysis of variance for abbreviated additive model[a], Webster County survey, June-July, 1963

	Degrees of freedom	Mean square	F value
Overall elasticities ($\hat{\alpha}, \hat{\beta}, \hat{\gamma}$ and composite variables)	12	9.10	5.58
Price by meat ($\hat{\alpha}_m$ | all others)	12	.85	.52
Price by socio-economic classes ($\hat{\alpha}_j$ | all others)	6	5.20	3.19
All explanatory variables	30	5.12	3.14
Error	3.185	1.63	

[a]Additive model in equation 22, excluding $\beta_m, \beta_j, \gamma_m, \gamma_j$, was used.

estimated standard error of the error variance estimates as noted in the prior section.

Main effect elasticities for price, advertising and in-store promotion and the interaction elasticities for price by socio-economic group were statistically significant at the .05 level. However, an F value of only .52 was obtained for price by meat interaction.

The signs of the price elasticity estimates shown in Table 13 were all negative with the exception of the coefficient for socio-economic group seven. But when determining elasticities corresponding to purchases of a particular meat by a particular socio-economic group (i.e. $\hat{\alpha}+\hat{\alpha}_m+\hat{\alpha}_j$), many positive values were obtained.

A partially multiplicative model

Significant estimates of elasticities for meat by price interaction were not obtained when fitting 22. Price elasticity estimates pertaining to specific meats and socio-groups were also often positive. As an attempt to overcome these problems the following model was formulated:

$$y_{mijt} = \alpha\alpha_m\alpha_j u_{mit} + \beta v_{mit} + \gamma w_{mit} + (\text{composite variables}) + e_{mijt} . \quad (28)$$

This model is identical to equation 22, as modified with respect to the interaction terms for advertising and in-store promotion, except for $(\alpha+\alpha_m+\alpha_j)$ being written in a multiplicative form, $\alpha\alpha_m\alpha_j$.

This model was fitted by an iterative process obtained by expanding the coefficients in a Taylor series. The first term can be written

$$\begin{aligned}\alpha\alpha_m\alpha_j &= (\alpha^\circ+\Delta\alpha)(\alpha_m^\circ+\Delta\alpha_m)(\alpha_j^\circ+\Delta\alpha_j) \\ &= (\alpha^\circ\alpha_m^\circ\alpha_j^\circ+\Delta\alpha\alpha_m^\circ\alpha_j^\circ+\Delta\alpha_m\alpha^\circ\alpha_j^\circ+ \\ &\quad \Delta\alpha_j\alpha^\circ\alpha_m^\circ + \ldots). \quad (29)\end{aligned}$$

Dropping higher order terms gives the interim model

$$\begin{aligned}y_{mijt} - \alpha^\circ\alpha_m^\circ\alpha_j^\circ u_{mit} &= (\Delta\alpha\alpha_m^\circ\alpha_j^\circ+\Delta\alpha_m\alpha^\circ\alpha_j^\circ+\Delta\alpha_j\alpha^\circ\alpha_m^\circ)u_{mit} \\ &\quad + \beta v_{mit} + \gamma w_{mit} \\ &\quad +(\text{composite variables})+e_{mijt} . \quad (30)\end{aligned}$$

The adjustments, $\Delta\hat{\alpha}$, $\Delta\hat{\alpha}_m$, $\Delta\hat{\alpha}_j$, derived from the fitted regression coefficients are added to the initial approximations for conducting the following regression.

Quadratic interpolation on the coefficients produced in the additive model was used to determine the initial values for α°, α_m°, and α_j°. These were then used for three iterations to produce the coefficients in Table 15. The largest value of $\Delta\alpha$, $\Delta\alpha_m$, and $\Delta\alpha_j$ for the final run was .039, while the mean absolute value was .011.

The F value for the entire model was 2.57 which is statistically significant at the .05 level. However, the amount of variation explained by the regression is considerably less than for the completely additive model used earlier. As before an F value less than unity was obtained for price by meat interaction.

The F value for the socio-economic group by price interaction was 2.36. This value is statistically significant at the .05 level.

Further simplification of the model

The F values associated with price by meat interaction elasticity were not statistically significant in either the abbreviated additive model or the multiplicative model. This suggested the removal of that component from the model. The model then becomes

Table 15. Price elasticities of quantity demanded obtained for multiplicative model[a] 27, Webster County survey, June-July, 1963

	Elasticity
Price ($\hat{\alpha}$):	-1.319
Price[b] by meat ($\hat{\alpha}\hat{\alpha}_m$):	
Beef:	
Hamburger	-1.571
Ground round, chuck, and lean	-.582
Chuck roast	-1.647
Round, swiss, chuck, cube steak	-3.148
Sirloin and t-bone steak	.086
Pork:	
Steaks and end-cut chops	-1.469
Chops-center cut	-.690
Bacon-second grade	-1.469
Bacon-first grade	-1.833
Cold meat:	
Wieners	-1.894
Balogna	-.667
Poultry:	
Whole fryers	-1.359
Cut-up fryers	-1.224
Price[c] by socio-economic group ($\hat{\alpha}\hat{\alpha}_j$):	
Group: 1	-1.406
2	-2.762
3	-2.614
4	-1.547
5	-.838
6	-.580
7	.504

[a] F value for fitting complete model was 2.57 which is based on 30 degrees of freedom in the numberator.

[b] F value for ($\hat{\alpha}_m$| all others) was less than one.

[c] F value for ($\hat{\alpha}_j$| all others) was 2.36.

$$y_{mijt} = \alpha_j u_{mit} + \beta v_{mit} + \gamma w_{mit}$$

$$+ \text{(composite variables)} + e_{mijt} . \qquad (31)$$

The parameter α_j as defined in 31 corresponds to either $(\alpha+\alpha_j)$ or $\alpha\alpha_j$ in the earlier models.

Earlier discussion suggested that price and quantity should be correlated negatively for meats. But both the abbreviated additive model and the multiplicative model produced a positive elasticity estimate for the seventh socio-economic group (Tables 13 and 15). A regression on 31 also produced a positive price elasticity for that group.

It was judged that the positive estimate of price elasticity was the result of random variation within the estimation process and that a preferred estimate would be simply to take price elasticity for the seventh group to be zero. Table 16 shows the results. The F value for the entire model was increased to 5.13 while the F for the socio-economic groups by price interaction was 3.39.

The model given by equation 31 was further simplified to

$$y_{mijt} = (\alpha+\alpha^{(I)}z_{1j}+\alpha^{(c)}z_{2j})u_{mit}+\beta v_{mit}+\gamma w_{mit}$$

$$+ \text{(composite variables)} + e_{mijt} \qquad (32)$$

where $z_{1j} = \log(\text{household income in \$1000 for } j^{th} \text{ group})$

and $z_{2j} = \begin{cases} 0 \text{ for households with no children under 13 years} \\ 1 \text{ for all others.} \end{cases}$

Table 16. Price elasticities of demand obtained when model[a] contains only price by socio-economic class interaction and value for seventh group is defined to be zero, Webster County survey, June-July, 1963

		Elasticity
Price by socio-economic group:		
Group:	1	-1.305
	2	-2.684
	3	-2.442
	4	-1.457
	5	-.819
	6	-.557
	7 (zero by definition)	.000
Mean of above		-1.323

[a]Model described by equation 31 was used. The F for the complete model is 5.13 while the F for the 5 degrees of freedom on interaction is 3.39.

In fitting this model, a restriction was placed on α, $\alpha^{(I)}$, and $\alpha^{(c)}$ such that

$$\hat{\alpha}+\hat{\alpha}^{(I)}z_{1j}+\hat{\alpha}^{(c)}z_{2j} = 0, \quad \text{for } j=7.$$

The results of this regression are shown in Table 17. Coefficients for the composite variables are included as well as t values for all variables. The F value for this fitting, at 6.17 is highly significant. The two degree of freedom explanation of the socio-economic effects on price elasticity explained essentially all variation in this interaction. The F value for the remaining 3 degrees of freedom was 1.73 which is not statistically significant at the .05 level.

Table 17. Summary[a] of elasticities of demand and composite variable coefficients, Webster County survey, June-July, 1963

	Coefficient	t value
Price elasticity (mean)	-1.305	-5.84
Price in terms of income and household compositions[b]		
Intercept	-3.061	-
Coefficient for $\log_e$(income in $1,000)	-1.297	4.36
Coefficient for household composition	-.844	-2.44
Advertising elasticity	.042	2.61
In-store promotion elasticity	.023	1.41
Composite variables:		
Price for same meat at other stores	.145	.31
Price for other meats at same store	-.972	-1.11
Price for all meats at other stores	2.414	1.47
Advertising for same meat at other stores	-.034	-1.86
Advertising for other meats at same store	.007	.15
Advertising for all meats at other stores	.063	.78
Promotion for same meat at other stores	.004	.26
Promotion for other meats at same store	.066	1.34
Promotion for all meats at other stores	-.103	1.40

[a]Model assumes price elasticity for socio-economic group number seven is zero. F value was 6.17 (13 degrees of freedom in numberator and about 3185 in denominator). R^2 was 0.029.

[b]Price elasticity = $-3.061 + 1.297Z_1 - 0.844Z_2$,
where $Z_1 = \log_e$(household income in $1,000).
$Z_2 = 0$ for households with no children under 13 years and $Z_2 = 1$ for others.

Interpretation

Possibly it should be emphasized again that the elasticities developed herein are store elasticities of quantity demanded. They indicate the proportional change in purchases

of a specific kind of meat from an individual store which can be related to a proportional change in price, advertising, or in-store promotion for that meat.

For example, the price elasticity averaged over all socio-economic groups and meats was found to be -1.305. Now suppose a retailer dropped his price of hamburger by 10 percent, but no other changes in the marketing environment occurred. Under the conclusion reached earlier that all meats have the same elasticity, the model suggests that the quantity of hamburgers purchased should increase by (-10%)x(-1.305) or 13 percent. The estimates on socio-economic groups by price interaction suggest that more of this increase in purchases will come from low income households than from high income households.

The model accounts for combinations of price changes, advertising, and in-store promotion in an additive manner. For example, it may be assumed that a retailer dropped the price of ground beef by 10 percent, and in addition, used a mean sized advertisement and a mean sized in-store promotion device. The 10 percent price change can be multiplied directly by the price elasticity coefficient to determine the response, but it is necessary to convert the use of the advertisement and the promotion sign to a percentage change basis. Retailer data showed that newspaper advertisements were used 37 percent of the time and in-store promotion devices 18 percent of the time by the eight store groups for the thirteen meats. Con-

sequently, the use of an advertisement corresponds to an increase in the advertising index of

$$\frac{1}{.37} - 1 = 1.70 .$$

The use of a mean sized in-store device corresponds to an increase of 4.56. Applying these proportional displacements to the model (Table 17) suggests that quantity purchased should increase by about

$$(-.10)(-1.305)+(1.70)(.042)+(4.56)(.023) = .31$$

or 31 percent.

It has been stressed that all elasticities up to this point pertain to adjustments in price, advertising, and promotion of a single meat by a single retail store (store group). But, what happens when a retailer lowers the price of several meats? Does quantity sold of each item remain about the same because the consumer now does not substitute the marked-down item for another item not marked-down? Or, does quantity go up even higher than would be expected by looking at the individual meat item coefficients by reason of the "big sale" attracting more buyers to the store?

An examination of the coefficients for the composite variables suggests the latter to be true. The coefficient for "price for other meats at same store" was -.972. Adding this to the mean price elasticity for individual meats of -1.305 gives an aggregate price elasticity of -2.277 which pertains to lowering the price of all meats. The estimated standard error

for this estimate is .922. This determines a t statistic of -2.47 when testing the hypothesis that the aggregate price elasticity is zero.

But a single store does not operate in a competitive vacuum. Competing stores are quick to counter price and advertising changes. Adding in the coefficients for "the same meat at other stores" and "all meats at other stores" gives an over all elasticity estimate of .282. Not only has the price effect been reduced considerably, but the sign has changed. However, the estimate of standard error for this estimator is 1.79. The t statistic corresponding to testing the hypothesis[1] of negative one elasticity of demand for all meat with respect to market prices is -.72. This result is indicative of the limitations of the data used herein; determination of market elasticity coefficients is simply beyond the aim of the research project.

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[1]Breimyer (4) by studying time series concluded that beef and pork possess unitary price elasticity of demand in the long run. Short run demand was found to be inelastic.

SUMMARY AND CONCLUSIONS

Factors affecting consumer demand for several classes of meat items were investigated. Consideration was given to socio-economic characteristics of individual households as well as to factors associated with the retail market. Factors having a significant effect on demand were isolated and elasticity coefficients for their quantitative effect on demand were estimated.

Data on which the investigation was based were collected by use of a consumer panel of 642 households in Webster County, Iowa in June-July, 1963. A system of panel rotation produced a collection period of seven weeks for the data used herein. Thus, the data possessed a time series as well as a cross-sectional character. Time series data were also collected on several aspects of the retail market.

A model relating consumer demand to the general factors of interest was developed upon traditional Paretoan consumer demand theory. Various linear models were developed to approximate the theoretical model. Classical regression methods were applied to estimate coefficients.

Several socio-economic attributes of the households were examined with respect to their effect on demand for meat. Among the attributes examined, it was determined that purchasing behavior could be most satisfactorily explained by

(a) household income, (b) household composition (presence of children), (c) size of household, and (d) age of household head. A significant correlation between education of the household head and purchasing was found for only two kinds of meat.

A linear model was used to relate independent variables based on the above four attributes to demand for meat. Demand was defined in terms of both quantity purchased and size of expenditure per person for twelve classes of meat items and four aggregations of these twelve. The variation explained by the four independent variables was significant statistically at the .05 level for all meat classes and aggregations.

Quantity purchased per person generally increased with household income and decreased with both presence of children and size of household. The effect of age of the household head could not be related to meat demand in the aggregate but only to individual classes. The relation of these attributes to expenditures can perhaps be most easily explained as the quantity effects just mentioned combined with price effects. Price paid for meats generally increased with both household income and age of household head but decreased with size of household. A correlation between price and presence of children was not determined.

These relationships were quantified in terms of elasticities for each meat class (Tables 5 through 9). In terms

of pounds per person, beef was generally more elastic with respect to income than was pork. Income had little effect on cold meat purchases. An increase in age was associated with increased purchases of beef roasts, ham, and poultry but decreased purchases of ground beef, pork chops, and cold meat.

When using proportion of total meat quantity as the independent variable, income was found to be related generally to an increased proportion of beef purchases and a decreased proportion of cold meat. Presence of children was related to an increased proportion of cold meat purchases. There appeared to be little relation between size of household and the proportion of various meats purchased. Pork, poultry and fish as a proportion of total meat purchases by a household could not be related significantly to any of the socio-economic characteristics considered.

Factors affecting consumer demand associated with the retail market were summarized by the variables (a) retail price, (b) an index of newspaper advertising, and (c) an index of in-store promotion. These three variables were quantified in the form of data series pertaining to thirteen meat classes, five store groups, and seven weekly time periods.

A linear model was formulated to relate the above data series as explanatory variables to a corresponding quantity of purchases series. When explaining the quantity purchased of a

particular meat at a particular store group, the model took into account not only the level of price, advertising, and in-store promotion of that meat at that store, but also the level of these variables for other meats and for other stores. Components were included in the model to treat interactions of price, advertising, and in-store promotion with both the classes of meat and the socio-economic characteristics of the households.

Statistically significant estimates of elasticities of quantity demanded with respect to price, advertising, and in-store promotion were obtained. But a variation in these elasticities among individual classes of meat (i.e. interaction) was not supported by the data. A clear interaction with socio-economic characteristics was determined only for the price elasticity. This relationship of price elasticity with socio-economic characteristics was reduced to one involving only income and household composition.

The estimated elasticities of quantity purchased from a retail store (group) with respect to price, advertising, and in-store promotion are:

(a) price: -1.305

(b) advertising: 0.042

and

(c) in-store promotion: 0.023.

The model indicated that the price elasticity becomes more

negative by the amount -0.844 for households with children. Price elasticity increased (decreased negatively) by the factor $1.297\log_e$(income in \$1,000).

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APPENDIX A: STUDY GROUP CHARACTERISTICS

The composition of the study group from the viewpoint of socio-economic characteristics, was quite similar in many respects to that of the nation as well as to the economic area in which Webster County is located. Table 18 provides a comparison on many important characteristics between 1960 U.S. Census data and study group data.

The mean size of household for the study group was 3.45 persons while the mean size was 3.29 persons for the nation. The study group contained a slightly larger proportion of older persons; about 39 per cent of the household heads in the study group were 55 years of age or older compared to only 34 per cent in the nation. Households in the study group were found to be less mobile from the viewpoint that only 13.6 per cent of these households moved into the county since 1955 as compared to a 20.3 per cent figure for the nation.

The educational level of the study group compared closely to the nation as judged by the level of attainment of the household head. The mean number of years of school completed was only slightly higher for the study group. But in terms of distribution, more noticeable differences were noted. Only 20.7 per cent of the household heads in the study group completed 8 years or less of school while nearly twice that

proportion, or 39.7 per cent, of all persons 25 years of age or older in the nation were classed in this attainment group.

The general distribution and mean level of income for households in the study group compared closely to that of families for the nation. The more significant differences in occupation were a lesser emphasis on the professional, technical, and kindred classes and a stronger emphasis on farmers, managers, and proprietors. But the emphasis on farming was not nearly as strong in the study group as was the case for the economic area of Iowa in which Webster County is located. Table 18 also contains comparative information on industry of work.

Mean household size and mean age and educational attainment of the household head is tabulated on the basis of household income in Table 19. It may be noted that the households with extremely low income consisted largely of older persons. Moreover, these families were much smaller and educational attainment was much lower. A large proportion of the household heads were retired.

A distribution of households by the two classifications of age of household head and family composition is provided in Table 20. The period in which children constitute an important influence on family consumption shows up clearly.

Table 18. Percentage distribution of socio-economic characteristics of study group compared to that of United States and area II in Iowa

Characteristic	1960 Census[a]		Webster County study group
	United States	Area II Iowa[b]	
Mean persons per household:	3.29	3.18	3.45
Age of head of household:			
Under 25 years	5.1	-	5.2
25 to 34 years	18.4	-	15.9
35 to 44 years	22.1	-	22.0
45 to 54 years	20.4	-	18.1
55 to 64 years	16.5	-	17.8
65 and over	17.5	-	21.0
Residency; moved into county since 1955:	20.3	18.5	13.6
Years of school completed by adults:[c]			
8 years or less	39.7	36.6	20.7
9 to 11 years	19.2	14.0	18.1
12 years	24.6	31.7	40.4
13 to 15 years	8.8	11.0	14.9
16 years or more	7.7	6.7	5.9
Income:[d]			
Under $1000	5.6	7.1	3.9
$1000 to $2,999	15.8	21.1	12.3
$3,000 to $4,999	20.4	27.1	23.4
$5,000 to $6,999	23.0	21.2	26.5
$7,000 to $9,999	20.1	14.0	21.0
$10,000 to $14,999	10.5	5.5	9.3
$15,000 and over	4.6	4.0	3.6

[a]Source: (48).

[b]Economic Area II of Iowa includes Boone, Calhoun, Clay, Dallas, Dickinson, Emmet, Franklin, Green, Hamilton, Hancock, Hardin, Humboldt, Kossuth, Osceola, Palo Alto, Pochahontas, Story, Webster, and Wright Counties.

[c]Data from U.S. Census are education of all persons over 25 years while study group data apply to household heads and homemakers only.

[d]Family income was used from U.S. Census to compare to household income in study group.

Table 18 (Continued)

Characteristic	1960 Census		Webster County study group
	United States	Area II Iowa[a]	
Occupation:[e]			
Professional, technical, and kindred	10.3	8.1	6.2
Farmers and farm laborers	8.3	35.8	14.0
Managers, officials, and proprietors	10.7	9.5	14.1
Clerical and kindred workers	6.9	3.5	5.9
Sales workers	6.8	6.1	8.8
Craftsmen, farmer, and kindred	19.5	13.2	15.8
Operatives	19.9	12.8	18.2
Service workers	6.1	4.0	4.7
Laborers	6.9	5.1	3.0
Homemaker, not working or occupation not reported	4.6	1.9	9.3
Industry:[e]			
Agriculture, forestry, fisheries and mining	10.5	28.4	14.4
Construction	8.4	5.9	4.6
Manufacturing	30.2	11.3	26.8
Transportation, communication & other public utilities	8.5	5.7	7.4
Wholesale and retail trade	17.0	19.2	18.5
Finance, insurance, and real estate	3.4	2.7	2.7
Business and repair services	2.9	2.0	3.0
Personal, entertainment, and recreational services	3.3	5.8	2.0
Professional and related services	6.9	13.9	7.1
Public administration	5.3	3.1	3.3
Industry not reported	3.6	2.0	10.2

[e]Employment data on all males over 14 years in U.S. Census are compared to employment data of household head in study group.

Table 19. Mean age and education of household head and size of household by annual household income, Webster County survey, June-July, 1963

Household income	Number of households	Household head age (years)	Household head education (years)	Household size (persons)
Under $1000	25	75	8.1	1.56
$1,000 to 2,999	79	64	9.2	2.13
$3,000 to 4,999	150	48	10.8	3.44
$5,000 to 6,999	170	44	11.1	4.01
$7,000 to 9,999	135	46	11.5	3.72
$10,000 to 14,999	60	45	13.0	3.77
$15,000 and up	23	54	13.8	3.65

Table 20. Percentage distribution of households by household composition and age of head

Household composition	Under 25	25-34	35-44	45-54	55-64	65 & over	Total
One-person households	-	-	0.3	0.4	2.1	7.1	9.9
Adults only:							
Homemaker under 40	1.5	1.2	0.3	-	0.1	-	3.1
Homemaker 40 or over	0.1	-	0.9	6.1	9.3	12.5	28.9
Adult(s) and children:							
Children pre-school only	3.3	5.8	0.6	0.1	0.3	-	10.1
Children 6-12 years only	-	2.3	2.9	2.0	0.6	0.6	8.4
Children 13-20 years only	-	0.1	1.8	5.5	4.0	0.8	12.2
Children in 2 or 3 age groups	0.3	6.5	15.2	4.0	1.4	-	27.4
Total	5.2	15.9	22.0	18.1	17.8	21.0	100.0

APPENDIX B: WEEKLY CONSUMER PURCHASES DIARY

Figure 11. First page of weekly consumer purchase diary, Webster County survey

STRATUM & Seg. _____
Household _____
Week No. _____
Interviewer _____

1963

DEPARTMENT OF ECONOMICS AND SOCIOLOGY
AND
STATISTICAL LABORATORY
IOWA STATE UNIVERSITY

WEBSTER COUNTY CONSUMER SURVEY

PART B

W E E K L Y C O N S U M E R P U R C H A S E D I A R Y

For Week of _____ through _____

MEAT ITEM Beef None ☐	Lbs.	Ozs.	Price per Pound	Total Amount Paid	U.S.Grade or Packer Label	Date Purchased	Store where purchased	Frozen when bought?	Was item stored in freezer?
Ground Beef,									
Hamburger									
Ground Round Steak,									
Lean Ground Beef									
Beef Liver & Baby Beef Liver									
Heart, Tongue & Other Organ Parts									
Chuck Roast (Pot Roast)									
Rib Roast Bone Removed ☐ Bone In ☐									
Boneless Rump Roast									
Other Roast Bone Removed ☐ Bone In ☐									

Chuck Roast (Pot Roast)										
Rib Roast Bone Removed ☐ Bone In ☐										
Boneless Rump Roast										
Other Roast Bone Removed ☐ Bone In ☐										
Round & Swiss Steak										
Sirloin Steak										
Porterhouse & T-Bone Steak										
Cube Steak or Minute Steak										
Other Steak Name _____										
Stewing Beef (Boneless)										
Boiling Beef or Short Ribs										
Other Fresh Beef Name _____										
Corned Beef										
Chipped Beef										
Other Cured or Processed Beef: Name _____										
Canned Beef										

APPENDIX C: MEAT CLASSIFICATION

Table 21. Prices, mean quantity and frequency of purchases for selected meat items, Webster County survey, June-July, 1963

	No. of purchases in sample	Mean price paid per lb.	Weekly purchases per person in lbs.	Grouping[a] used for: Cross classification tables	Regressions on socio-economic factors	Regressions on price and offer variation
Beef:						
Ground-hamburger	851	$.45	.31	*	*	*
-ground round, chuck, lean	183	.65	.05			*
Roast-chuck	250	.59	.12	*	*	*
-all other	111	.80	.06	*		
Steak-round, swiss, chuck, cube	359	.79	.11	*	*	*
-sirloin, t-bone	280	.97	.11	*		*
Chipped, dried, corned	177	1.38	.01	*	*	
All other beef	154	.46	.04	*		
Total beef	2365	.64	.81	*	*	
Pork:						
Chops-loin, center	271	.71	.07	*	*	*
-loin, end	71	.48	.02			*
Steak	62	.51	.02			
Fresh ham sliced, cutlets, tenderloin	152	.66	.03			
Bacon-first grade, sliced	358	.59	.07	*	*	*
-second grade, sliced	191	.48	.05			*
-all other	67	.38	.03			

[a]The symbol * denotes a group.

Table 21 (Continued)

	No. of purchases in sample	Mean price paid per lb.	Weekly purchases per person in lbs.	Grouping[a] used for: Cross classification tables	Regressions on socio-economic factors	Regressions on price and offer variation
Ham and picnic	265	.70	.14	*	*	
Roast, fresh	86	.54	.04	*		
Sausage, fresh bulk & link	150	.46	.03	*	*	
All other pork	81	.49	.03	*		
Total pork	1754	.60	.53	*	*	
Cold meat:						
Wieners	583	.51	.12	*	*	*
Bologna	434	.56	.07	*	*	*
Other cold meat	858	.73	.11	*		
Total cold meat	1875	.60	.31	*	*	
Poultry:						
Broilers & fryers, whole	119	.32	.09	*	*	*
Broilers & fryers, cut-up	426	.39	.26			
All other poultry	101	.49	.04			
Total poultry	646	.38	.39	*	*	
Fish	427	.75	.06	*	*	