

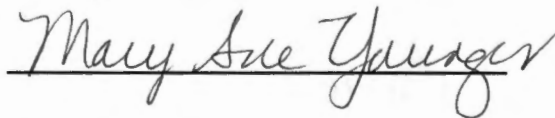
To The Graduate Council:

I am submitting herewith a thesis written by John Stanley Shoaf entitled "The Analysis of Tray and Vacuum Packaging Methods and How They Affect Beef Steak Sales." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.



David B. Eastwood, Major Professor

We have read this thesis
and recommend its acceptance:



Accepted for the Council:



Vice Provost
and Dean of The Graduate School

THE ANALYSIS OF TRAY AND VACUUM PACKAGING METHODS
AND HOW THEY AFFECT BEEF STEAK SALES

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

John Stanley Shoaf

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CHAPTER I

INTRODUCTION

Concern about declining per capita consumption of beef has fostered a great deal of research into its causes, as well as possible ways of reversing the trend. In response to the decline in beef consumption, a number of technological developments have been introduced. One of them is a new type of packaging for fresh beef, vacuum packaging. Vacuum packaged beef has the advantages of increased convenience, safety and longer shelf life over the conventional tray packed beef. However, there is an acceptance problem due to color of the beef.

A number of studies have estimated retail demand for individual food items. Most of them have addressed the demand for food items without looking specifically at the type of packing used when the product was sold. The type of packaging, though, could be a major factor in influencing the consumer. Although there have been studies of different types of packaging, only a few have focused on the packaging of fresh beef. This project explores consumers' preferences toward two types of packaging for fresh beef.

Scan data are a relatively new way of recording what is sold by

stores. When each item is sold, it is passed over a scanner which reads a bar code on the package. The bar code contains information about the item being sold. Scan data present the opportunity to compare the patterns of actual customers' purchases of fresh beef to vacuum packaged beef where the only difference is the packaging. In order to do this other variables in demand and supply equations must be fixed. These are variables such as shelf space, type of cut, brand name, price, income, consumer preferences and the store selling the beef. This allows one to look specifically at the packaging.

There are two basic types of packaging for fresh beef. Tray packed refers to carcass and boxed beef that is cut in the store. The meat is then put on display in styrofoam trays wrapped in clear plastic. Vacuum packed fresh beef comes from the packing plant pre-wrapped in air tight packages ready for food shoppers. Beef in these packages only requires refrigeration.

There are a number of important advantages to continuing with tray packed fresh beef. Consumers are familiar with this type of packaging. The color of the beef is particularly crucial. The visible bright red color is an indication of the quality and freshness of beef. Another advantage is that some older consumers like to have personal conversations with their butchers. They may feel this ensures they are getting the best cuts for their money. An in-store meat cutter is also able to provide food shoppers with custom cuts of meat. For example, diet conscious consumers and people with heart problems may still want to consume meat and want to have the extra fat trimmed away from the steak.

There are some obvious advantages for the store using vacuum packaging. First, it cuts down on losses due to spoilage. Meat can only be kept for so long in the store before it must be discarded. Vacuum packaging extends the shelf life of the meat and allows the store to display it longer. Labor costs of the meat department can be reduced because the vacuum packed beef comes in consumer-ready packages. In addition, the store does not have to allocate as much space for cutting facilities.

Consumer advantages of using vacuum packed beef are also important. They do not have to freeze the meat within several days after purchase. When consumers buy the tray packed meat, it has to be consumed fairly soon, or it has to be frozen. The shelf life for vacuum packed beef is about the same as the frozen life for tray packed beef, about six months. Also, consumers have to let tray packed beef thaw or use a microwave before the piece of beef can be cooked. With vacuum packed meat, consumers store the beef in the refrigerator, not the freezer. All consumers need to do is remove the vacuum packing, and it is ready to cook. This can significantly reduce the consumer's time cost of preparing the beef for a meal. Another advantage is that each steak is individually wrapped. This is a big help for consumers because the tray packed beef should be rewrapped for freezing.

Perhaps the biggest disadvantage of the vacuum packaging is the color. Consumers understand that the red color of the meat in the tray pack indicates the beef is fresh. The meat gains a red tint because it is exposed to the oxygen in the air. Without oxygen, as with the vacuum packaging, the purple-red reduced myoglobin pigment is formed and

persists throughout the product's display life (Lynch, Kastner and Kropf). Beef in vacuum packaging has a faded brown color. Once the seal is broken, and the beef is exposed to oxygen in the air, it turns the familiar red color. Thus, consumers need to recognize that the brown color vacuum packed beef is normal. There has been research to find a synthetic material that can be injected into the meat that will help it gain a red tint in vacuum packaging. However, such a process would have to be approved by the FDA, and there is additional concern about consumer acceptance of any food that has been treated with chemical additives.

1. OBJECTIVES

The purpose of this study is to learn more about consumer purchase patterns of tray packed versus vacuum packed fresh beef. The study will use scanner information from a multi-regional supermarket chain having stores in the Knoxville, Tennessee area. The study pertains to steaks only and focuses on similar cuts that differ only in the type of packaging used. Each cut considered is offered at the same price and is displayed in the same area in the supermarket.

The measures considered are levels of sales, variations in sales, timing of peaks and troughs, and duration of cycles in weekly sales. Levels are compared to determine if there are important differences in the number of packages sold per week. The packaging with consistently lower levels of sales are considered to be less preferable to consumers, ceteris paribus. Variability in sales is evaluated through inspection of graphs of the time series.

Comparisons of peaks, troughs, and directions of change from the previous week are described for tray pack versus vacuum pack beef. This helps determine if purchase patterns over time are similar. The durations of cycles (peak to peak and trough to trough within each series) are considered. Here the purpose is to determine if the stock adjustment periods, the number of weeks that typically elapse before consumers restock, are comparable. Trends in the tray versus vacuum packed sales are compared. This provides some indication of whether consumers are starting to accept one type of package over the other. The study also determines whether the trend is flat, increasing or decreasing.

A regression model is also developed and tested. Weekly product movement of selected tray and vacuum packed cuts of steak are considered to be functions of the price of the cut, type of packaging, a trend, advertising measures, an interaction between the type of packaging and the trend, and the Fourth of July and Labor Day holidays. Other variables could be eliminated due to the nature of the problem setting. The statistical model permits inferences regarding the causal effects of the various independent variables on product movement. Results allow inferences to be drawn regarding consumer acceptance of the vacuum packed product.

CHAPTER II

REVIEW OF THE LITERATURE

1. CHANGES IN MEAT DEMAND

Meat consumption has been changing in the United States over an extended period of time. This is shown on a per person basis by the data in Table 1. Per capita annual consumption data for three major types of meat are shown for the period 1970-1988. Figure 1 displays these consumption data to permit visual inspection of the series for trends and easy comparison.

Beef consumption increased from 84.4 pounds per capita in 1970 to 94.3 pounds per capita in 1976 with 1976 being the peak year. Then, there were three years of relatively large declines, so that per capita consumption fell to 78.0 pounds per capita in 1979. Between 1979 and 1986 there were small yearly changes, positive and negative, so that by 1986 per capita consumption was 78.4 pounds. There was a decrease of 5.0 pounds the following year, and a slight decline of 1.3 pounds in 1988 leading to 72.1 pounds per capita consumed.

The second series is the per capita consumption of poultry from 1970 to 1988. There was little change in these data from 1970 to 1975,

Table 1.

Consumer Price Index and Per Capita Consumption for Meat, Poultry, and Pork.

Year	<u>Per Capita Consumption</u> (lbs. Retail Weight)			<u>Consumer Price Index</u> <u>1982-84=100</u>		
	Beef	Poultry	Pork	Beef	Poultry	Pork
1970	84.4	36.5	61.9	43.5	53.2	45.4
1971	83.7	36.3	67.9	45.5	53.5	41.1
1972	85.5	37.9	62.4	49.7	54.2	47.6
1973	80.5	36.9	57.0	59.6	76.0	63.3
1974	85.4	36.9	61.4	61.3	72.1	63.0
1975	88.0	36.5	50.5	61.9	79.7	77.1
1976	94.3	39.6	53.6	59.9	76.4	78.1
1977	91.4	40.8	55.8	59.9	76.9	73.9
1978	87.2	43.5	55.8	73.1	84.9	83.4
1979	78.0	47.4	63.7	93.1	89.1	84.7
1980	76.4	46.7	68.1	98.4	93.7	81.9
1981	77.1	48.2	64.9	99.2	97.5	89.5
1982	76.8	49.6	58.5	100.6	95.8	101.0
1983	78.2	52.6	61.9	99.1	97.0	100.1
1984	78.1	52.6	61.5	100.3	107.3	98.8
1985	78.8	55.1	62.0	98.2	106.2	99.1
1986	78.4	56.3	58.6	98.8	114.2	107.2
1987	73.4	60.2	59.1	106.3	112.6	116.0
1988	72.1	61.5	63.1	112.1	120.7	112.5

Source: Putnam, J.J. "Food Consumption, Prices, and Expenditures, 1967-88." United States Department of Agriculture. Economic Research Service, Statistical Bulletin #804, May 1990.

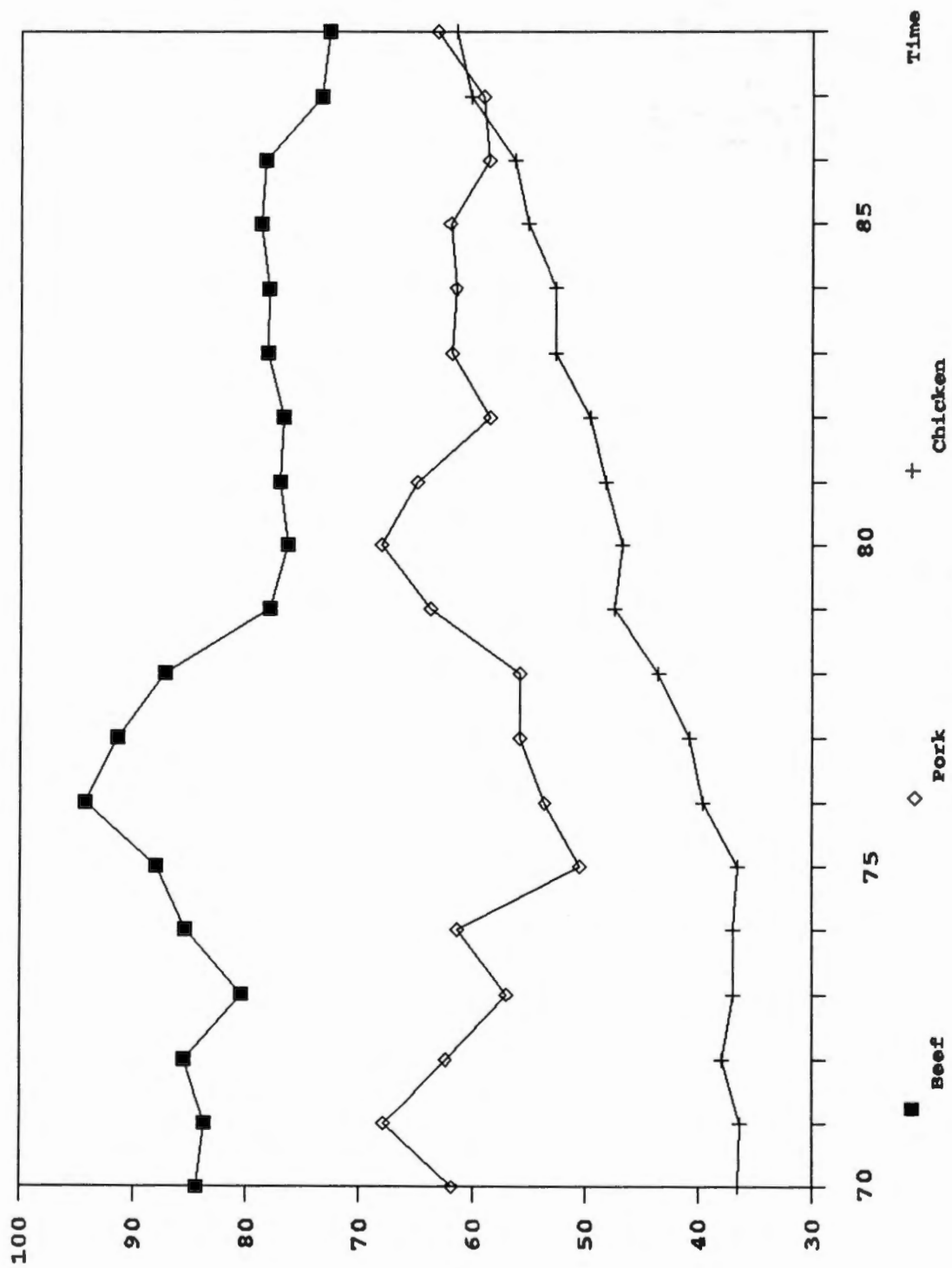


Figure 1. Per Capita Consumption of Beef, Poultry, and Pork.

which averaged 36.83 pounds for the subperiod. Per capita consumption was 36.5 pounds in 1975, and it rose steadily throughout the rest of the period. By 1988, the peak year per capita poultry, consumption was 61.5 pounds.

The third column of Table 1 presents per capita consumption of pork data. This was the most erratic of the three series. Peaks occurred in 1971 (67.9 pounds), 1974 (61.4 pounds), and 1980 (68.1 pounds). The cycles appear to dampen following the 1980 peak. In 1988 per capita consumption was 63.1 pounds.

Levels of consumption were quite different in 1970, with pork consumption was 70 percent higher than poultry, and beef consumption 22.9 pounds higher than pork. However the relative consumption patterns over the last 19 years changed. Poultry consumption rose to where it was slightly below pork consumption, and beef fell somewhat but was still greater than poultry and pork consumption. Beef and pork appear to have experienced opposite cycles, whereas poultry underwent steady growth. There were slight declines in beef consumption and pork consumption while the consumption of poultry doubled.

2. EXPLANATIONS OF CHANGING CONSUMPTION

Empirical models of consumer demand focus on factors that cause changes in consumption. These include the effects of income and relative prices. However, other determinants are also important and include quality changes in products, changes in the demographic composition of the population, and changes in consumers' preferences.

A. Prices

Data in the last three columns of Table 1 provide price relative information for the 1970 to 1988 period for each of the respective meat consumption categories. Figure 2 displays these data. Beef prices increased in relative terms from 1970 to 1974 by a 40.9 percent change. There was very little change between 1974 and 1977. From 59.9 in 1977 there is a sharp rise in the price index to 98.4 in 1980. The series returned to small increases for the 1980 to 1986 period. Sharp increases in the price index occurred during the last two years so the levels rose to 106.3 and 112.1, respectively.

There is little change in the price index for poultry over the 1970 to 1972 period. Then there is a sharp increase in 1973 of 40.2 percentage points. The price index falls in 1974, rises in 1975, and is followed by two years of slightly lower prices. The poultry price index rose steadily through the rest of the period, with the exceptions of 1982 and 1985 when there are slight declines.

The real price of pork decreases from 1970 to 1971 by a 9.5 percent change (45.4 verse 41.1). Between 1971 and 1973 the price series increases from 41.1 to 63.3. There is a decrease in the price relative of .5 percent from 1973 to 1974. This price series rises from 63.0 in 1974 to 78.1 in two years. During the period from 1976 to 1977, the percent decrease is 5.4. Between 1977 and 1979 the price relative of pork rose from 73.9 to 84.7. The 1980 price relative was 3.4 percent lower than that of the preceding year. Relatively large increases occur in the following two years, raising the price relative to 89.5 and 101.0, respectively. The price index falls somewhat over the next two years.

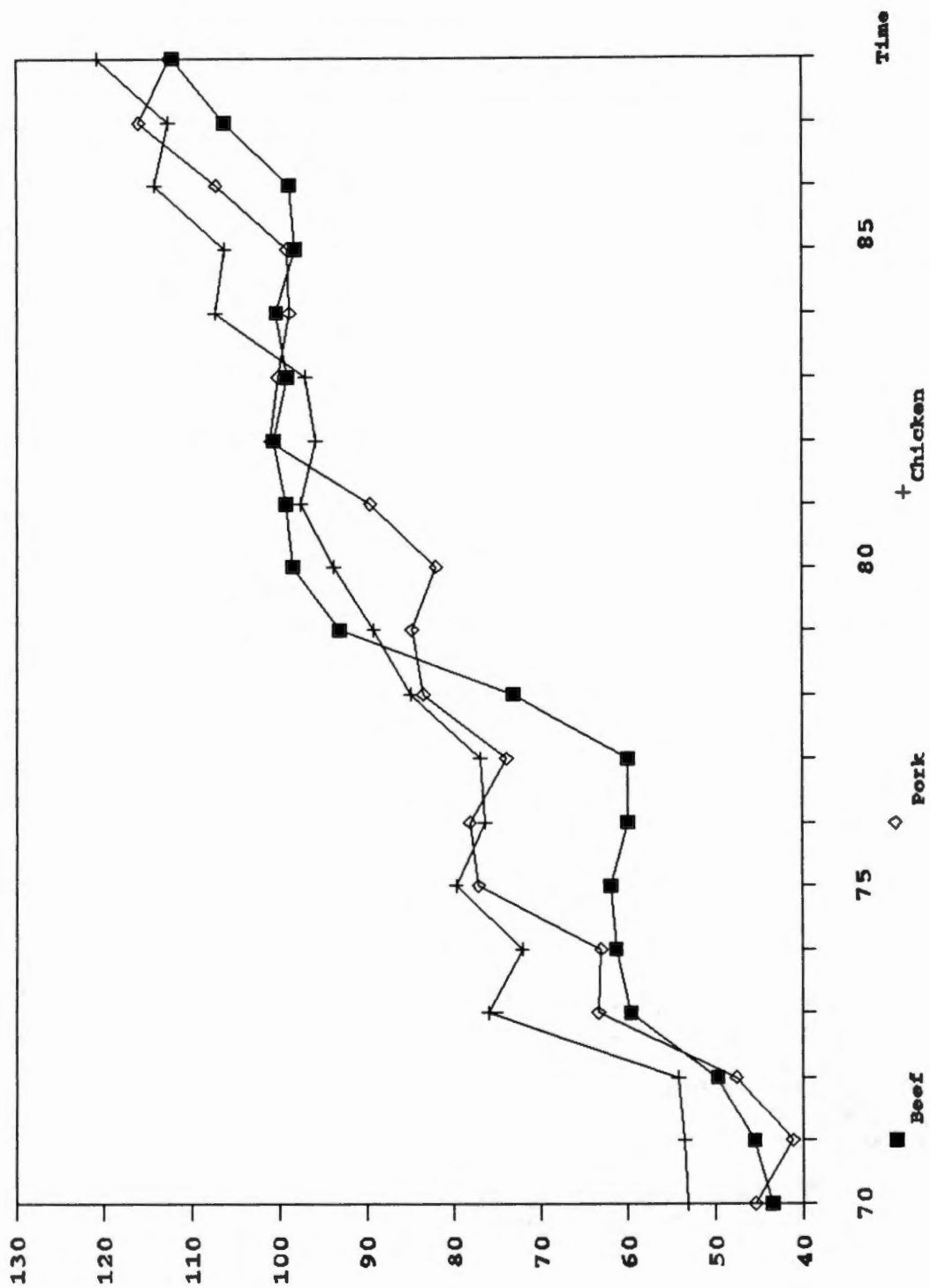


Figure 2. Consumer Price Index of Beef, Poultry, and Pork.

A small increase occurs in 1985, and for 1986 and 1987 there are large increases. The 1988 price relative of 112.5 is 3.0 percent lower than the 1987 level.

The three price series remain close together over the time period. Since these are price relative for 1982-1984 = 100, it is also necessary to consider the actual price levels. Beef has traditionally had higher prices per pound than poultry. This realization, in conjunction with the price relative data, suggest that the relative price of beef versus poultry has been rising. Correlations between each per capita consumption series and real price series support this interpretation (see Table 2). The correlation between per capita consumption of beef and its price relatives were $-.81$ for the 1970-1988 period, whereas the corresponding one for poultry is $.93$. The price relative of beef rose by a 158.9 percent change, and beef consumption declined. However, as the price relative of poultry rose by a 126.9 percent change, poultry consumption rose, indicating that the price of beef relative to poultry has risen over this period, thereby causing, in part, the substitution from beef to poultry. The small pork price relative of 1.48 suggests that the relative price of pork did not change enough vis-a-vis beef to cause much substitution.

These correlations are consistent with a study by Buse (1989). Buse compared representative samples of households' food consumption in two different periods. The first sample used data from 1965, and the other sample used data from 1977-78. Buse found that red meat demand was not affected very much by the price of poultry products, but poultry demand was affected positively by red meat prices. This indicated that,

Table 2.

Correlations Between Beef, Poultry, and Pork Consumption and Consumer Price Indices.

	Price of Poultry	Price of Pork	Cons. of Beef	Cons. of Poultry	Cons. of Pork
Price of Beef	.95	.93	-.80	.93	.23
Price of Poultry		.97	-.69	.93	.01
Price of Pork			-.61	.92	-.11
Consumption of Beef				-.77	-.55
Consumption of Poultry					.20

as poultry prices rose, consumers were not inclined to substitute red meat, but as beef prices rose, they tended to switch to poultry. Thus, part of the cause of changing meat consumption can be tied to the changes in the relative prices of products within this food group.

B. Diet and Health

Changes in consumer preferences away from fresh beef have been influenced by media coverage of the relationship between diet and health. Consumers are becoming more aware of the healthier types of meat to consume. In particular, consumers are becoming concerned with the amount of animal fat in their diets.

Capps and Schmitz (1990) studied how health information and nutrition factors affect food demand. Annual data were drawn from the USDA disappearance series covering the period 1966 to 1988. These data measure food consumption as the difference between annual production and changes in stocks, exports and imports, and nonfood uses. The dependent variable was per capita consumption of meat. The independent variables were a cholesterol-information index; meat expenditures; and prices for beef, pork, poultry, and fish. The cholesterol-information index was based on the number of articles that discussed cholesterol in medical journals during a year. This index served as a proxy for information reaching the consumer. Four equations (beef, pork, poultry, and fish) were estimated, and the cholesterol information index was significant in all equations except for beef. Chicken and fish expenditures were positively related to the cholesterol index, whereas pork was affected negatively. These results suggest that providing consumers with

relevant information about meat products affects their consumption of these foods.

C. Quality Changes

The chicken industry has developed new products with attributes that are more in line with emerging lifestyles. Whole chicken traditionally had been offered to the consumer. Now the chicken industry supplies precooked, boneless, skinless and other conveniently packaged products at prices that are competitive with beef.

Faced with competition from new poultry products that are relatively cheaper and supposedly more healthful, the beef industry was forced to take stock of the situation and act (Linsen). The beef industry has not developed comparable changes in the way fresh beef is made available to consumers. The form in which cuts of fresh beef have been sold at the retail level has experienced little change. Linsen concluded the beef industry should learn from its mistakes and look into the ways the poultry industry achieved its success.

A broad thrust is underway in the development of beef products designed to enhance consumers' value perceptions (Allen and Pierson). Stores are offering steaks with more of the fat trimmed away. Some beef cuts, such as ground beef, are now offered in a lean form. Product development also includes nontraditional packaging such as vacuum packed beef. As explained below, this process makes beef available to consumers in a form that is more in line with current life styles.

D. Advertising

In years past consumers were inclined to accept what the supermarket offered because there were limited choices among processed foods and because fresh items may not have been in season or could not be delivered. Through the adoption of new technologies, growing practices, and better transportation, consumers now can choose among more food products. Given that consumers have more choice, suppliers are in a more competitive market. This has changed food retailing (Supermarket Business, March 1988).

Retail advertising gives producers and retailers the opportunity to inform consumers about their products. Price information is one of the important messages to convey to food shoppers. Advertising also provides the opportunity to promote new products or to inform consumers about new technologies that affect existing foods.

Both chicken and beef have been promoted on the basis of their contributions to healthy diets. The chicken industry has advertised that its products contain less animal fat than beef. Beef industry promotions focus on the improved quality of beef and that it is "real" food. The increased chicken consumption (Table 1) coupled with research such as that conducted by Capps (1989) suggest that the chicken industry has been able to convey positive information about its products, whereas the beef industry, with its declining consumption, has not been as successful in promoting its products.

Tellis (1988) argues that the beef industry must advertise the quality changes in its new products if the decline in per capita consumption is to be curtailed. However, the advertising should not be

generic, where beef is promoted as a single commodity. Rather, marketing should focus on specific cuts, such as steaks.

E. Demographics

Changes in the demographic composition of population can affect food consumption patterns. Research has shown that food consumption varies among population subgroups (e.g. Buse, Smallwood and Blaylock 1985). Consequently, even though the eating habits of different age-sex-race cohorts remain the same over a period of time, changes in the proportional composition of the population can lead to changes in food demand.

Smallwood and Blaylock studied how household size and income affected food purchases using the 1977-78 Nationwide Food Consumption Services. The data were collected from April 1, 1977 to March 31, 1978 from 15,000 households from 48 states. The dependent variable was the expenditure on the commodity. The independent variables were income of household, size of household (both of which were used in quadratic form), and income of household times size of household. The results for beef, pork, and poultry varied. For beef they found as income increased there was a slight increase in beef expenditure. The expenditure on pork increased as household size increased. Poultry expenditure increased quite substantially as household size increased, but it was unresponsive to income.

Buse's (1989) study used more disaggregate meat consumption data. He found some diverging trends within red meat. He found that the percent of the budget spent on beef products increased with income, as

households switched to more expensive cuts. Food consumption patterns were found to change by the stage of the life cycle.

Taken together the work of Smallwood and Blaylock (1981) and Buse (1989) indicate that part of the changing consumption patterns portrayed in Table 1 are the result of the changing consumer population. The chicken industry appears to have benefitted from the changes, whereas the beef industry has been adversely impacted. These changes seem to have had little impact on pork consumption over the 1970-1988 period.

F. Cost Changes

A contestable market is defined as a market in which there is no barrier to firms entering or leaving (Baumol). Barriers (e.g. patents, contracts, economies of scale) can allow existing businesses to earn abnormal profits without the threat of their being competed away through new entrants. The potential for increased competition causes firms in contestable markets to act as if they were operating in a purely competitive situation. In this environment, any cost savings will not lead to increased profits, but rather, will be passed on to consumers through lower prices. The reason is any savings that lead to increased profits would foster the entry of competitors' outlets. Thus the supermarket can either lower prices to discourage entry or have prices fall due to increased competition.

Supermarkets operate in contestable local markets (Eastwood 1990). Chains, whether large or small, earn rates of return that are about average for the typical U.S. business (Supermarket Business, 1990). This means that any cost savings a supermarket may achieve are quickly

passed on through lower prices to food shoppers. With respect to poultry, supermarkets have been able to avoid meat cutting operations. The poultry industry has become vertically integrated, and economies of scale have been achieved by the processors. However, the beef industry has not experienced structural change comparable to poultry sector (Chavas). Meat cutting operations are still needed at the store level for beef. Consequently, the savings in poultry processing have been passed on to consumers while the relative price of beef has risen over time. If beef could be prepackaged at the processor level, labor could be relocated to other areas such as the merchandising of meats--merchandising which responds more directly to consumers' changing demographics and lifestyles (Allen).

3. MARKETING/PROMOTIONAL STUDIES

Experience goods are ones whose qualities consumers are unable to assess until they are used (Eastwood 1985). Foods are experience goods because they have to be eaten before consumers can judge their qualities. If the consumers are satisfied with the good currently consumed, these people are less likely to try a new substitute product because the new ones could be less desirable, so the money would be wasted. Consequently, consumers are reluctant to buy new foods.

One way for sellers to overcome the reluctance to purchase an experience goods is to conduct marketing/promotion studies to identify promotions that prompt consumers to purchase different goods. This research centers on product characteristics that tend to form consumers' attitudes toward products. Research into the determinants of consumers'

tastes, preferences, and demand have looked at choice uncertainty and knowledge uncertainty and how they affect consumers' search behavior. These studies help processors' marketing efforts. The more uncertainty about product quality, the more search required (Urbany, Dickson and Wilkie). If consumers are not presented with enough information through advertising or other promotions about new products or changes in existing products, they may not purchase them even though they are better.

Kumar and Leone (1988) studied brand promotions of disposable baby diapers and their influence on consumers' decisions about where to shop. The study used weekly data for a sixty week period. The study was conducted in a medium sized city in the Southwest using different stores. The dependent variable was sales. The independent variables included the price of the product and whether brand was promoted. Also, variation in price from week to week was used to measure the in-store price promotion. Other types of advertising, such as T.V., radio, and newspaper, were included. When the brand was promoted, it was measured as a dummy variable. They concluded that presence of a promotion did increase sales. Also, they concluded that consumers would change stores due to promotional activities. Their result suggests that if beef was promoted with a brand name sales may increase due to brand recognition.

One possible advantage of the poultry industry is that its products have brand names whereas beef does not. Poultry processors can try to associate quality with a brand name. To the extent this is successful, poultry processors can introduce new products more easily

than the beef industry. Brand name recognition and acceptance can help to overcome the experience good hesitancy on the part of consumers to purchase new foods.

Wilkinson, Bonfield, and Mason (1975) studied the relationship between consumer recognition of a reduced price and its advertisement in a newspaper. They found that the more consumers purchased a food item, the more likely consumers would recognize a price saving through advertising. The less prominent the food item, the more trouble consumers had recognizing the price saving. This result helps to explain beef and poultry consumption patterns. Wilkinson, Bonfield, and Mason found that brand name promotions of poultry in the newspaper featuring price reductions have better consumer recognition than beef price reductions advertised in the newspaper. Consequently, poultry consumption is much more likely to be affected positively by promotions than beef consumption.

Two broad types of consumer panels were identified by Lynch, Kastner, and Kropf (1986). Both can be useful tools for estimating product marketability. One was called the marketplace consumer panel. These consumer panels measure what consumers are purchasing each time they go to the store. The other type of consumer panel was experimental. The distinctive feature of these panels was that consumers were asked to evaluate products in nonpurchase settings such as interviews. Both types of panels have given manufacturers and marketers insights regarding consumers' attitudes and perceptions of products (McLaughlin and Rao).

Lynch, Kastner, and Kropf (1986) studied the effects of product

color and education materials on the intent to purchase vacuum packaged ground beef. The experimental data were collected during six days in August 1984. Consumers were given questionnaires by interviewers. A respondent's purchase decision was found to be a function of appearance, fat content, price per package, price per pound, color, and packaging. They concluded that informed consumers are more likely to purchase vacuum packed beef than uninformed consumers. Also fat content was the single most important factor to consumers when purchasing.

McLaughlin and Rao (1990) studied the accept/reject decisions of new products carried by supermarket chain. The data were collected from June 1986 to February 1987 from food buyers for a large supermarket chain in the Northeast. The determinants of the decision were vendor supplied information (e.g., size of package), financial information (e.g., gross margin, profit, and suggested retail price), promotional information (e.g., vendor effort and marketing support), and interviewee responses to questions about product characteristics (e.g., product uniqueness and brand names). About 2,000 new products were involved. They found that product acceptance grew when the product had a brand name. Promotion also increased the amount of product acceptance. With large amounts of promotion these products were accepted more than products with low promotions.

The changing patterns of food consumption suggest that the beef industry needs to provide retail products that are more suitable to consumers' preferences. Packaging, with its technical and marketing characteristics, is an important way to improve consumers' value perceptions of a product (Pelzer, Menkhaus, Whipple, Field, and

Hoffman). Informing consumers of benefits of new packaging could overcome some reluctance to buy due to the new foods' experience problems.

Pelzer, Menkhaus, Whipple, Field, and Hoffman (1990) studied factors that influenced consumer rankings of vacuum packaged steaks and roasts. The data were collected from Denver and Los Angeles during May and August of 1989. The dependent variable was the respondents' preference of package type (1-highest preference and 3-lowest preference). The explanatory variables included several groups of variables: demographics (e.g., age, sex, and household size), storage (freeze or refrigerate), product characteristics (e.g., taste, fat content, visibility of the product in the package, cholesterol content, familiar bright red color, and ease of preparation), use patterns (e.g., eating fresh beef less often, having steak more often, appropriate for special occasions, and serving poultry more often), overall opinion, in-store promotions (pamphlets and/or demonstrations), and location. They found that consumers who increased the consumption of poultry did not prefer vacuum packaged steak. The color of the vacuum packed steaks was identified as a problem among those who expressed low preference.

Taken together, these marketing/advertising studies indicate that improvements in food packaging need to be explained to consumers in order for them to be incorporated into the decision making. If consumers do not know about new types of packaging, they may not buy the new item due to the inertia associated with experience goods. This may lead to the failure of a new product even though it may have many beneficial characteristics.

4. ECONOMIC DEMAND STUDIES OF BEEF

A. Traditional

Economic studies of consumer demand are based upon the assumption that consumers maximize utility subject to constraints, of which the most common is the budget constraint. Determinants of demand are prices, income, and other socioeconomic variables, including advertising. Prices include the own-price and those of substitutes and complements.

Marion and Walker (1978) estimated a short-run model of meat sales. The weekly data were for a chain located in Ohio and covered a fifty-two week period. The dependent variable was pounds of product sold. Independent variables were own-prices of cuts, prices of substitutes, a trend, temperature, and dummy variables for seasonality, payday, and advertising. They concluded that temperature, season, own-price, and payday were significant determinants of the pounds sold per week. Most relevant to the present study, newspaper advertising had no significant effect on product sales. They felt this result was due to the small week to week changes in the chains' meat advertising.

Funk, Meilke and Huff (1977) studied the effects of retail prices and advertising on fresh beef sales. Their weekly data covered the period from January 1974 through May 1975. The study pertained to individual supermarkets in the Toronto area. The dependent variable was weekly beef sales in the respective chain. The independent variables were the chain's price of beef, competitors' beef prices, the chain's substitute prices, competitors' substitute prices, own advertising, competitors' advertising, and seasonal factors. They concluded that the

higher the quality of the cut, such as filet mignon, the more price elastic the cut of beef. This means that the higher quality the cut of beef, the more responsive weekly beef sales were to price. Also, own meat advertising for specific cuts was found to have positive effects on sales.

Eales and Unnevehr (1988) studied separability and structural change in U.S. retail demand for beef and chicken. The annual data covered the period from 1965 through 1986. In the general model, the dependent variable was the amount spent by consumers on each type of meat. The independent variables were prices of the whole bird, parts and processed chicken, hamburgers, table cuts of beef and pork, and nonmeat foods and total expenditure on all commodities in the model. They concluded that hamburger and whole chicken were inferior goods because the estimated income elasticities were negative. Chicken parts and beef table cuts were found to be normal goods because the estimated income elasticities were positive and less than one. They also concluded that the structural change shift to chicken from beef started in 1974.

Alston and Chalfant (1990) used parametric and nonparametric tests to identify structural change. Their model centered on beef demand. The dependent variable in the parametric test was per capita consumption. The independent variables were real price and real expenditure on beef in the respective year. Nonparametric tests involved calculations of expenditure inequalities that must hold in order for utility maximization to occur. They used two data sets, one for the United States and one for Canada. Parametric tests involved

explicit functional forms of the demand equations and results varied by data set. They concluded that the aggregate per capita time-series data contained problems that made it hard to investigate structural change.

B. Scan Data

Scan data are an alternative source of information about consumer marketplace behavior. Traditional time series lack detail on individual foods. Furthermore, they do not have timeframes that are consistent with consumer decision making for many items. Quarterly or annual data for food demand, in particular, do not reflect the consumers' time horizon for food purchases.

Cross-section consumption data typically involve large samples of consumers and their purchases over a very short period of time. These data provide more detail on the items bought, as well as socioeconomic information about the consumers surveyed. Because the data cover short intervals, such as a week, the expenditures may not reflect consumption due to changes in the levels of stocks. For example, food purchases during a week may not reflect consumption because some of them may be additions to food stocks and some of the food used may come from previous purchases. Another problem with consumer surveys is the time and inconvenience associated with collecting the data (Capps 1989).

Scan data do not have these problems. One desirable feature is the potential degree of product specificity. This gives researchers the opportunity to conduct consumer studies on individual foods. Scan data can be collected in weekly observations, which are more consistent with the time horizon in food demand. Through the creation of an historical

record, scan data give the researcher enough weeks to have a time-series.

Jensen and Schroeter (1989) studied retail beef demand using panel scan data. Panel scan data are collected from a consumers who are selected and issued account cards. The cards are then presented to the cashier before each purchase of consumer items recording price, quantity, and product description for each week. The weekly data covered a 92 week period from late 1985 through mid 1987. They were collected in Grand Junction, Colorado by a marketing research company. The dependent variable was the aggregate quantity of purchases for all types of fresh beef. The independent variables were sex of the head of the household, race, educational attainment of the head, the number household members, an index of beef prices, average real price paid for beef, whether the beef was bought on sale, price of chicken, price of pork, a behavioral variable for different panels, and television advertising. They concluded that nonwhite families purchased more beef than white families. Households headed by females purchased less beef than households headed by two adults. College-educated households purchased half of the beef purchased by noncollege-educated households. They also found that television advertising was insignificant.

Capps (1989) studied retail beef demand using weekly scan data for the period from January 1986 to June 1987. Weekly data were used because consumers generally restock once a week. They were collected by a supermarket chain in Houston. The dependent variable was sales per thousand customers. The independent variables were own-price, price of substitutes, holiday, a trend, payday, seasonality, advertising of own-

product, advertising of substitutes, and sales of the previous week of the dependent variable. He concluded that for most of the meats own-price, substitute price, holiday, and advertising were significant. He also found that payday was not significant.

Economic studies, as opposed to marketing studies, have been based on models of consumer behavior. Empirical work has tended to focus on market behavior via price and income effects. Advertising was usually incorporated in an ad-hoc fashion. Marketing studies have been less concerned with a theory of behavior such as utility maximization but have shown the relevance of packaging and ought to be included in economic studies of individual products. They tended to involve experimental settings and focused on individual products, packaging, advertising and promotions. Although economic and marketing studies have utilized different approaches to studying consumer demand, both are consistent with an underlying economic principle. Quantity demanded is a function of own-price, prices of related goods, advertising, seasonal factors, demographics, and income.

5. VACUUM PACKAGING

The beef industry must compete with other meats for the consumer's food dollar. One way of doing this is to develop improved packaging techniques. Tray packaged beef, which is the standard method, is placed in a styrofoam tray and wrapped in plastic. Oxygen is able to penetrate this type of packaging, which gives beef the red appearance. Vacuum packaging is a new technique. Vacuum packaging takes all the oxygen out of the package, and then it is sealed. In the package the beef is not

exposed to oxygen. When beef is not exposed to oxygen, it has a blue-purple color. A consumer does not associate this color with the freshness of beef because consumers have learned through experience that the appropriate color of fresh beef is bright red (Urbain).

The color problem may overshadow the advantages of vacuum packaging. Supermarkets would not need to hire as many meat cutters in each store. Less store space could be allocated to meat cutting operations. Losses due to spoilage would be curtailed because of the longer shelf life. Reduced handling of beef beyond the meat packer level would occur, thereby keeping the product fresher. These savings could be passed on to consumers via the contestable nature of food retailing. Consumer benefits are not limited to lower prices. The product does not have to be rewrapped. There is no need to freeze it. Consequently, the beef is ready to use, thereby making it more suitable for current life styles.

Chicken and pork can be vacuum packed. The color of these products is the same whether tray or vacuum packed. This is a plus for processors, because consumers need not be re-educated about the color.

A related problem that the beef industry is facing is the absence of retail brand recognition. Most fresh beef at the retail level has no packinghouse label. Thus, a packer who wants to introduce an innovative product has difficulty in marketing it to consumers. Unless there is a patent, a free rider problem may inhibit individual packers from going to the expense of providing consumers with relevant information. Until this issue is sufficiently addressed vacuum packaging may have an acceptance problem.

CHAPTER III

DATA AND METHODOLOGY

1. DATA

A. Scan Data

The scan data used in this research were gathered from a multi-regional supermarket chain. These data provided item movement (defined below) and price observations for different cuts of steak sold by that supermarket chain having stores in the Knoxville, Tennessee area. The data were collected from five stores and covered 130 weeks starting with the week ending May 14, 1988 and ending with that of January 5, 1991. The five stores were distributed over the metropolitan area and represented a large share of the area's supermarket sales. Four of the five stores generally had between twenty and twenty-five thousand customers per week, while the other supermarket almost always had fewer than ten thousand customers per week. Plots of customer counts by store by week indicated that none of the stores had a visible trend in customer accounts. Since there was no trend in customer counts, there was no need to adjust the data for weekly differences in patronage.

The data represent weekly totals of item movement for each bar

code. They were accumulated at each of the five supermarkets and forwarded to the chain's corporate headquarters once a week. Computer tape copies were sent to the University of Tennessee at Knoxville, and the information was added to the historic record. Special software is used to transform individual customer's purchases into the data that have been sent. These data become the corporate level information base which is different from customers' bills.

The historic record generated in this fashion contains missing weeks for the various stores. Missing corporate level data are the result of mechanical failures at the store level or problems at the headquarters' computing facility. Problems at the supermarket level generally result in the data being lost for just that store. If the problems are with the headquarters' computer system, the data may be lost for all stores for that week. There are eight weeks of missing data in this study that are common to all stores. They are the weeks ending Nov. 19, 1988, Dec. 31, 1988, July 22, 1989, Oct. 28, 1989, Feb. 2, 1990, May 26, 1990, Sept. 22, 1990, and Oct. 27, 1990.

Weekly scan data, as noted in Chapter 2 in Capps (1989), are well suited for demand analyses because promotional activities and advertising last for a week. This creates the opportunity of matching the chain's promotions to product movement. Weekly data are also appropriate from the consumer's perspective because consumers typically shop for food on a weekly basis.

Bar codes are sequences of 12 digits that can be read by scanners. UPC codes are standard codes that are given by the UPC Council which assigns unique 12 digit numbers to products. The first six digits

denote a manufacturer, and the last six digits denote specific products of that business. UPC bar codes are unique. NonUPC bar codes can be used for other products, but they are not unique. Fresh meats do not have UPC codes, so the supermarket chain assigns bar codes to the cuts that are consistent with the outlet's data processing system, but these nonUPC codes cannot be used to identify unique products outside of a chain's control. These nonUPC bar codes vary from store to store. For example, the bar code used by one supermarket to designate tray packed round steak can designate a completely different product by another supermarket chain.

A list of all the fresh beef steak bar codes was obtained from the scan data set. Examination of the descriptions of fresh beef bar codes led to the identification of four matched pairs of cuts of steak, one tray and one vacuum packed. For example, the round steak that was tray packed had the code 201090200000, and a round steak that was vacuum packed had the code 201443000000.

The corporate management system software does not aggregate customer sales. Instead, only the number of times each bar code is read is recorded, which is called item movement. However, item movement can be used as a proxy for quantity (number of pounds) sold. The reason is that the distribution of package sizes for any cut of fresh meat does not change very much from week to week. For example, if the average size of a package of filet mignon is 7 ounces, it has remained at approximately that level for an extended period of time. Consequently, any change in pounds sold per week would be reflected in a change in item movement.

Prices for each bar code by store and week are included in the scan data. The price is cents per pound. These prices are manually entered into the stores' computer files, so coding errors occur. Since all the stores charge the same price, many of the obvious errors, such as \$.10 per pound, could be corrected. These changes were accomplished through a visual inspection of a printout of weekly prices by cut by store. The same price per pound was charged for each tray and vacuum packed cut of steak.

The following seven figures display average of item movement by cut by week for the reporting stores. The averages are simple averages of the item movements across the stores that transmitted data for the respective week. This procedure yielded time series that had fewer missing data than the store level series but permitted visual comparisons of the tray versus vacuum packed series for each cut on the basis of levels of item movement, the presence of trends and seasonal patterns, the extent of the variations within each series, and the coincidence of cycles.

Figure 3 shows item movement for both tray packed and vacuum packed filet mignon over time. Since the two curves overlap, there is no long term difference between the levels of item movement of tray versus vacuum packed filet mignon. No tendency for the series to converge or diverge is observed. There is a large amount of weekly variation in item movement within each cut. No trend is evident in either series. Seasonal patterns are found in both series. Tray and vacuum packed item movements have troughs in the winters, followed by rising item movements through the early summers. Cycles in both series

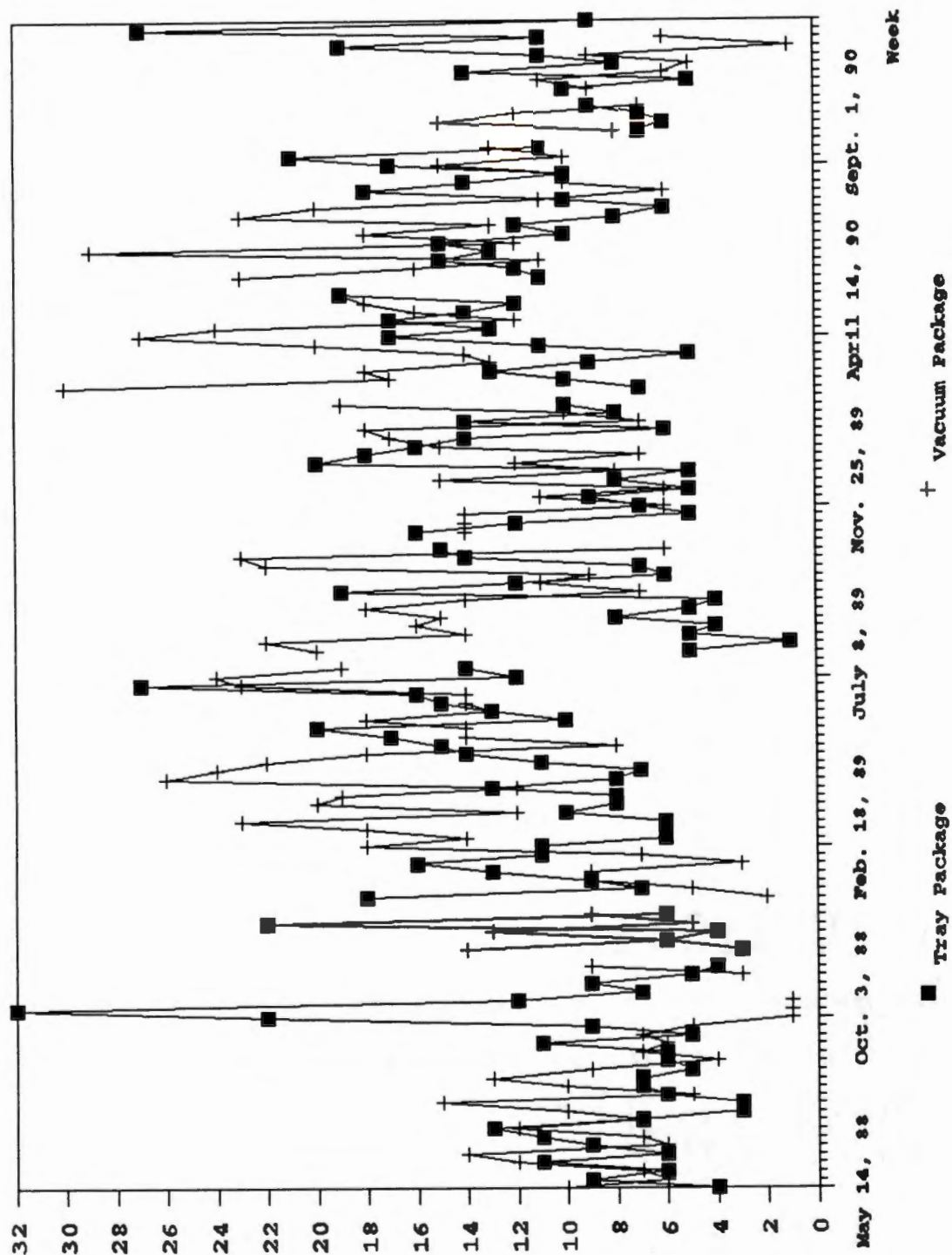


Figure 3. Filet Mignon Item Movement by Week.

appear to be two to three weeks long. The timing of peaks and troughs between the series seems to be independent.

Figure 4 shows weekly item movements for tray packed and vacuum packed round steaks over time. The tray packed round steak has consistently higher levels of item movement than that of the vacuum packed. No seasonality is present in either series. A small downward trend in the tray packed series appears to be present, but more is seen in the vacuum packed series. Peaks in the tray packed series seem to occur every four to six weeks. Periods of lower item movements in the tray pack series last several weeks. Variations in the vacuum packed series are very small compared to those for the tray packed series. Much of this is due to the lower levels of item movement in the vacuum packed series. There is a tendency for the vacuum packed round steak to have the same timing of peaks and troughs as the tray packed round steak during most of the period, but the vacuum packed item movement shows little change during the last eight months.

Weekly item movements of tray packed and vacuum packed chuck steaks over the time period are displayed in Figure 5. Tray packed chuck steak has generally higher levels of item movement than the vacuum packed chuck steak during the summer months. Very low levels of item movements for both cuts occur during the winter months. Slight downward trends seem to be present over the entire period. For several weeks preceding July 8, 1989, vacuum packed chuck steak seems to follow the tray packed item movement. Irregular movements in both series are present. There does not appear to be any convergence of the series.

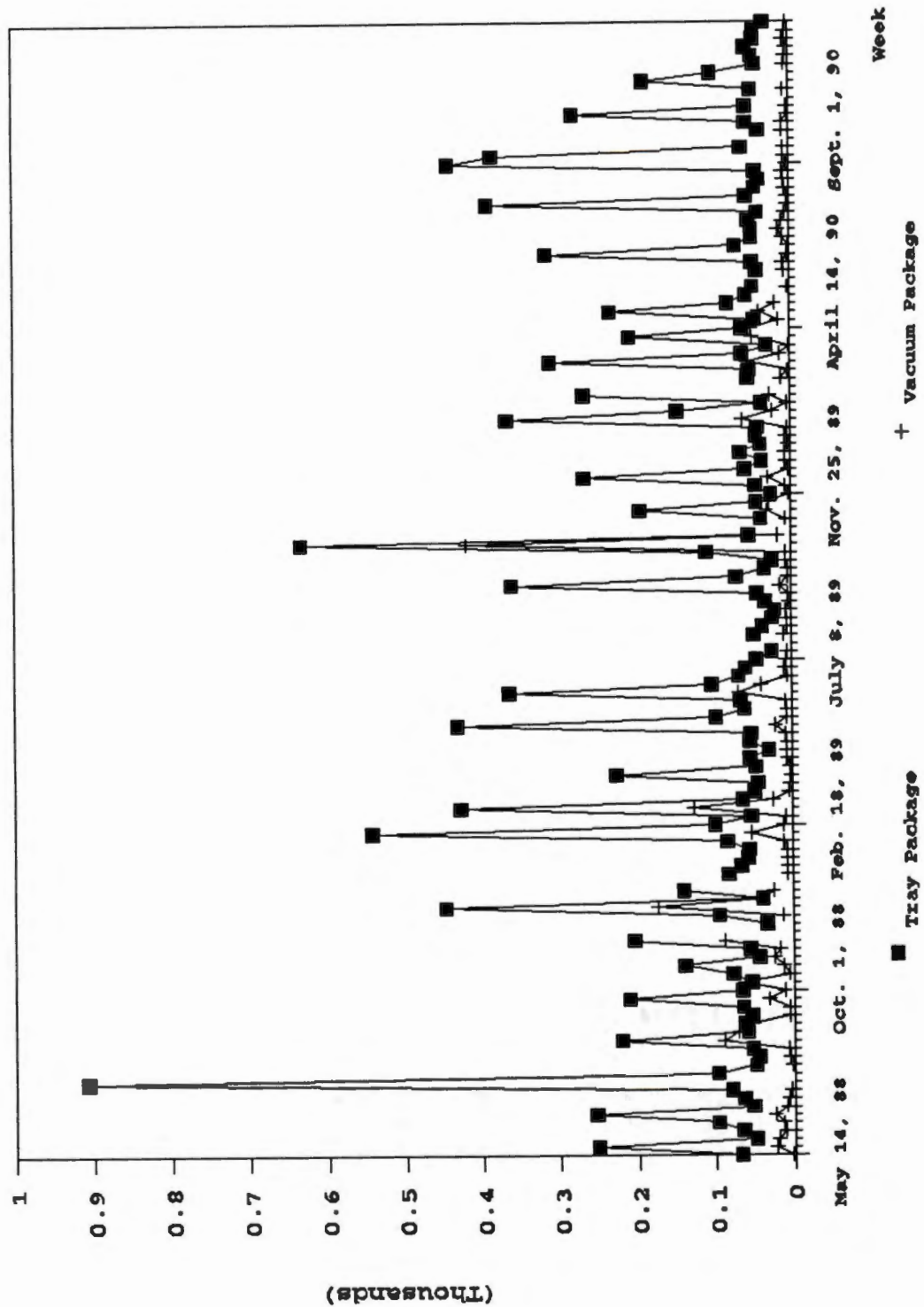


Figure 4. Round Steak Item Movement by Week.

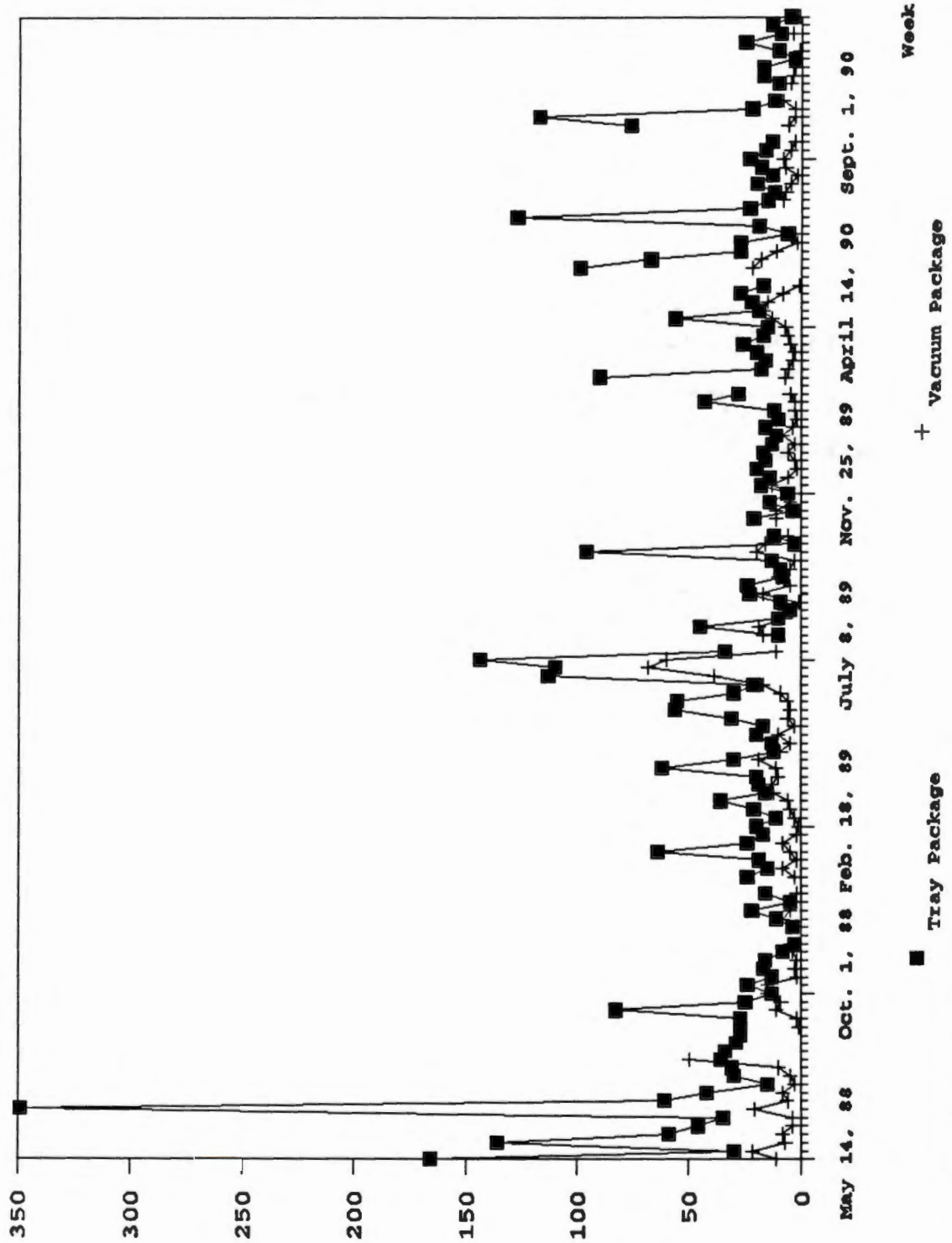


Figure 5. Chuck Steak Item Movement by Week.

Figure 6 shows weekly item movements of tray and vacuum packed cubed steak over time. Item movement for the tray packed product is consistently above that for the vacuum packed. However, there is a slight downward trend in the tray pack series, suggesting some convergence. There is a great deal of variation in item movement of the tray packed cubed steak but little variability in the series for vacuum packed cubed steak. No consistent patterns of peaks and troughs within or between the series are observed.

Semi-logarithmic graphs were generated (Figures 7 through 10) as a smoothing technique. This was done to adjust for the differences in the wide levels between tray and vacuum packed steaks and also to accommodate the large variations within the tray relative to the vacuum packed steak series.

Figure 7 shows the natural logs of item movements for tray packed and vacuum packed filet mignon over time. The two series overlap, just as in Figure 3, but the fluctuations have been reduced. There does not appear to be a tendency for one series to be consistently greater than the other. The seasonal pattern noted in the Figure 3 discussion is also visible. Perhaps, a slight upward trend in both series is present. The timing of peaks and troughs appears to be irregular and unrelated.

The plots of the natural log of item movement for tray packed and vacuum packed round steaks over time are displayed in Figure 8. This graph shows the level of item movement for tray packed round steak is consistently greater than that of vacuum packed round steak. The peaks and troughs of tray and vacuum packed round steaks tend coincide during the first half of the period and tend to be out of phase during the

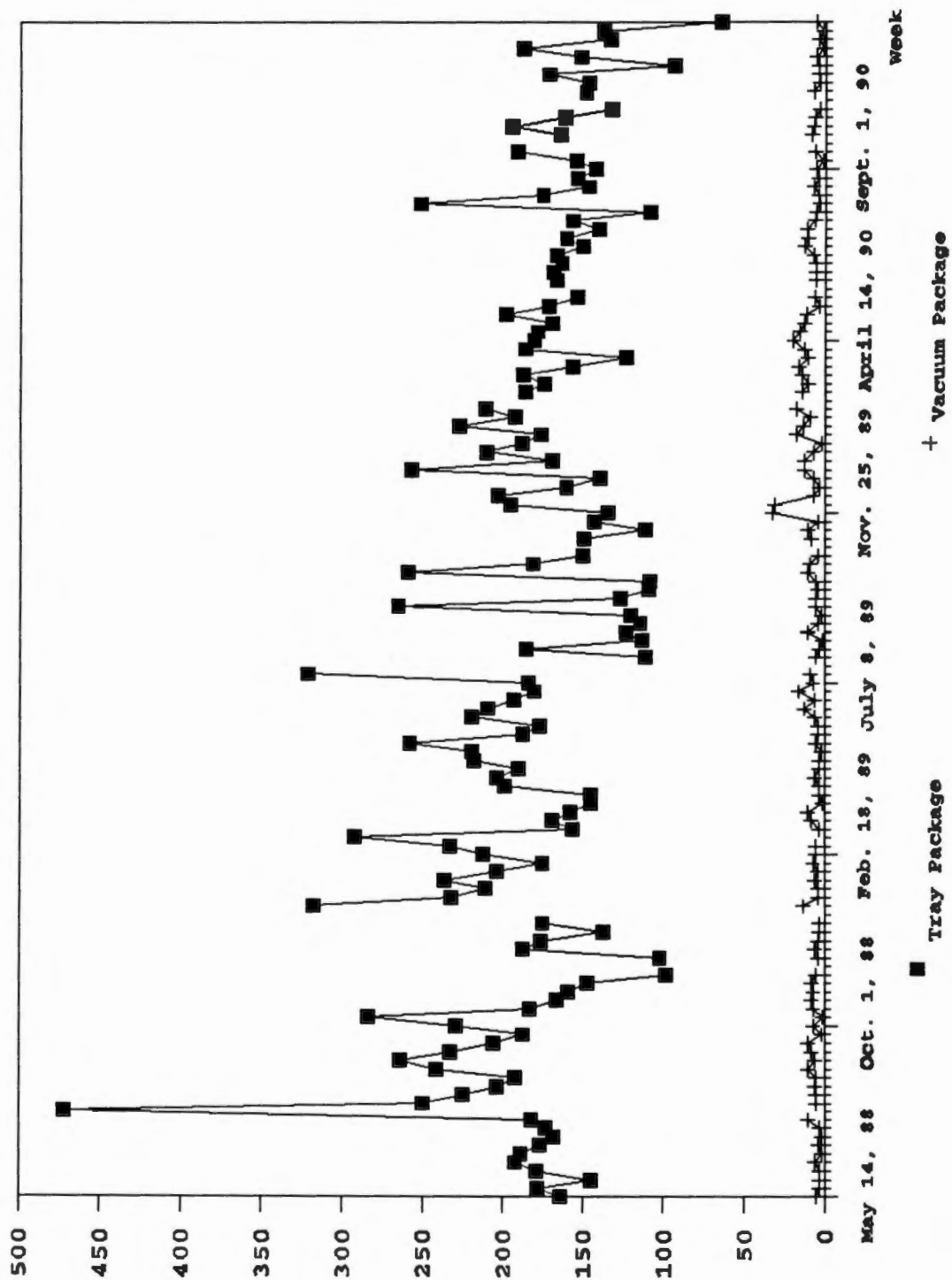


Figure 6. Cubed Steak Item Movement by Week.

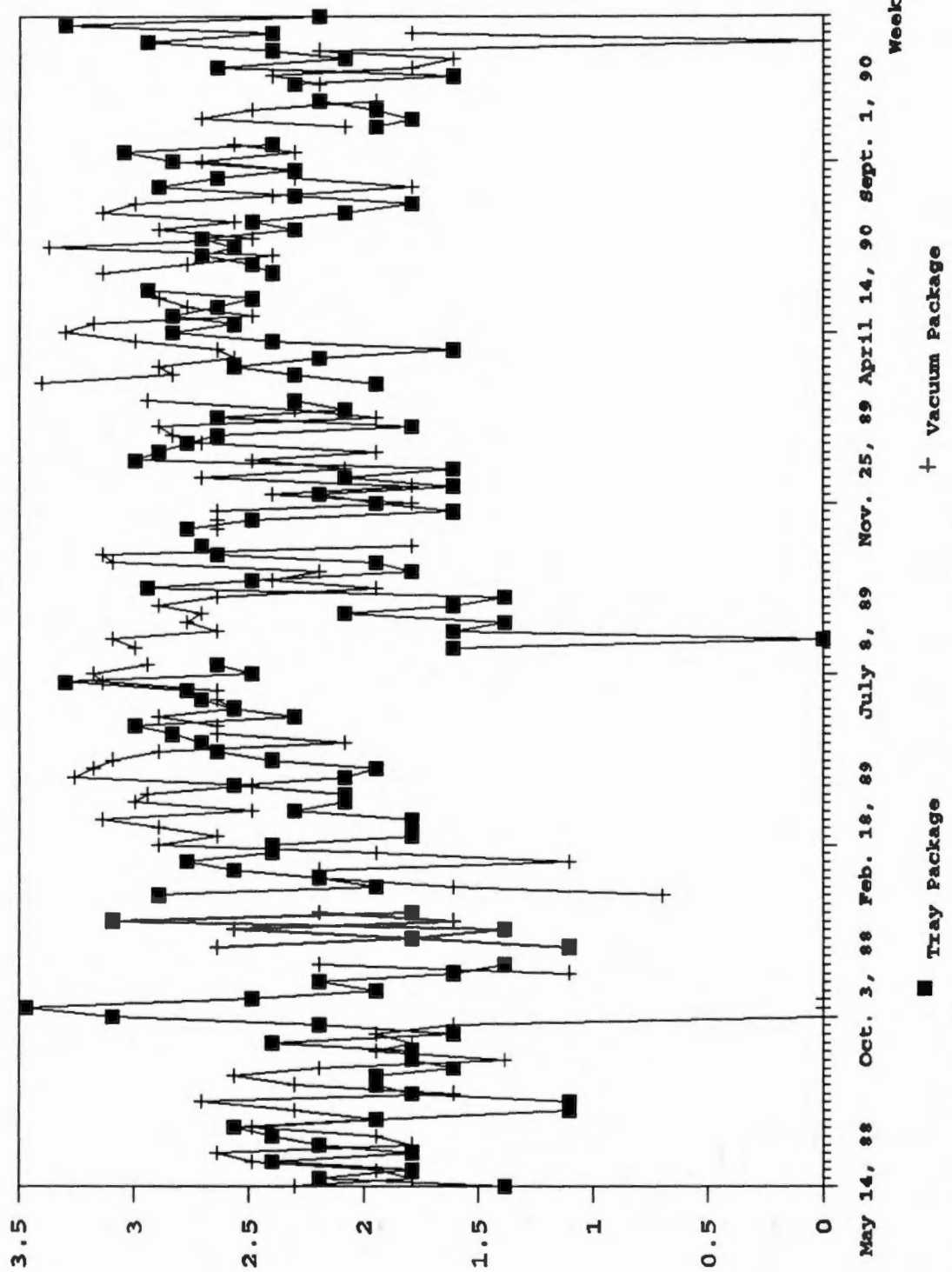


Figure 7. Natural Log of File Item Movement by Week.

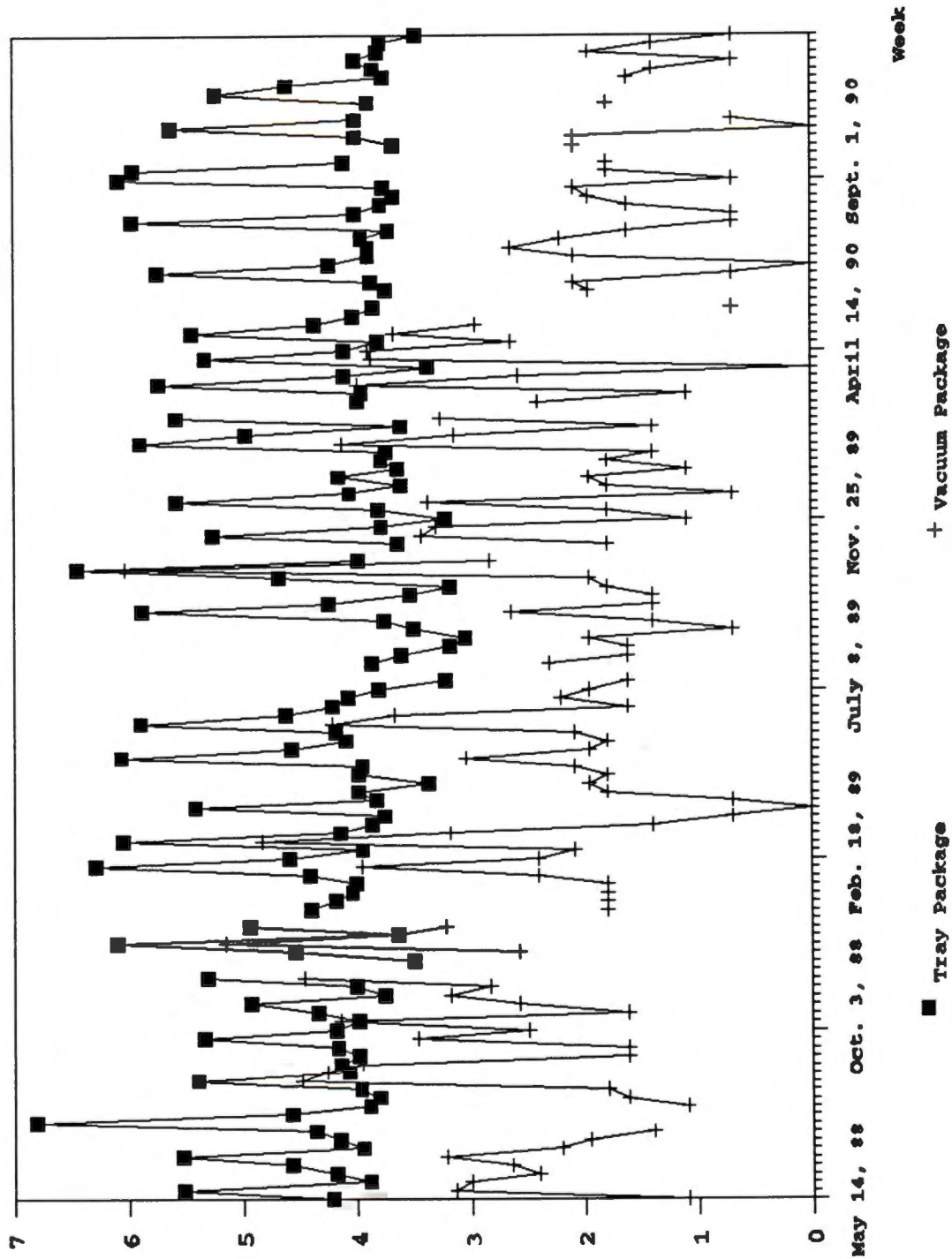


Figure 8. Natural Log of Round Steak Item Movement by Week.

second half. Comparisons of the variations between the series suggest they are similar with two or three exceptions where the changes in the vacuum packed series are quite large. There is a downward trend for the vacuum pack series and, perhaps, a slight overall decline for the tray pack, which are not visible in Figure 4.

The natural logs of item movements for tray and vacuum packed chuck steak over time are displayed in Figure 9. This graph shows the levels of item movement of tray packed are generally greater than those for vacuum packed chuck steak. The tray packed series shows a decline over the period, whereas the vacuum pack series does not seem to have one. Both series display large week-to-week fluctuations. The timing of the peaks and troughs generally occur in four to six week intervals and do not coincide.

Figure 10 shows the natural log of item movement for both tray packed and vacuum packed cubed steak over time. This graph shows a large difference in the levels between tray and vacuum packed cubed steak. The vacuum packed series has a positive trend through November, 1989, whereas no trend is apparent in the tray packed series over this subperiod. Both series have negative trends from January 1990 through the end of 1991. The fluctuations in the series seem to be unrelated, and those for vacuum packed item movement are larger than those for the tray packed. Coupled with the discussion of Figure 6, this suggests that in terms of percentage changes, the vacuum paced series has relatively larger fluctuations.

The timing of peaks and troughs for tray versus vacuum packed were also evaluated in a separate analysis. Peaks and troughs for each time

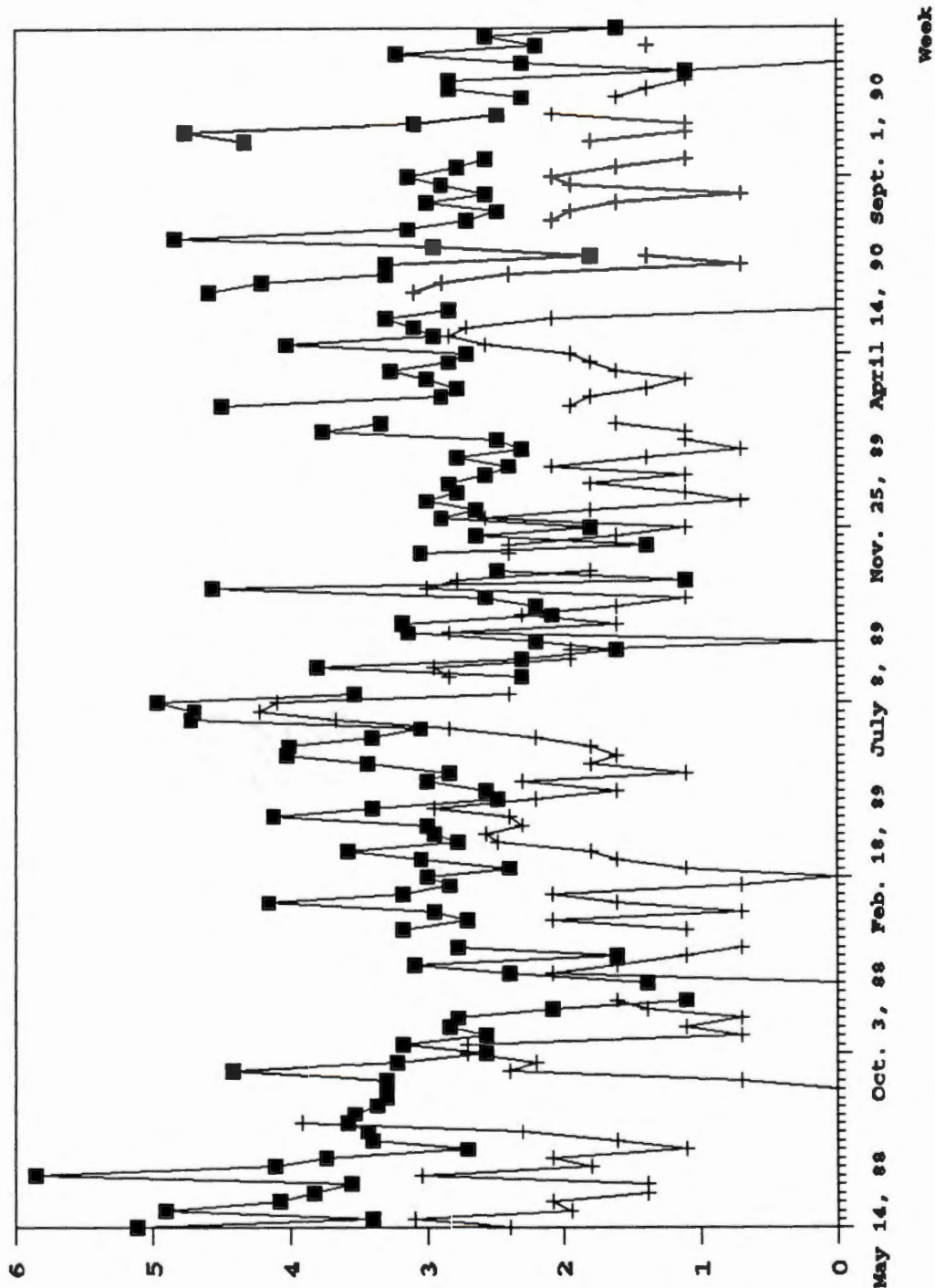


Figure 9. Natural Log of Chuck Steak Item Movement by Week.

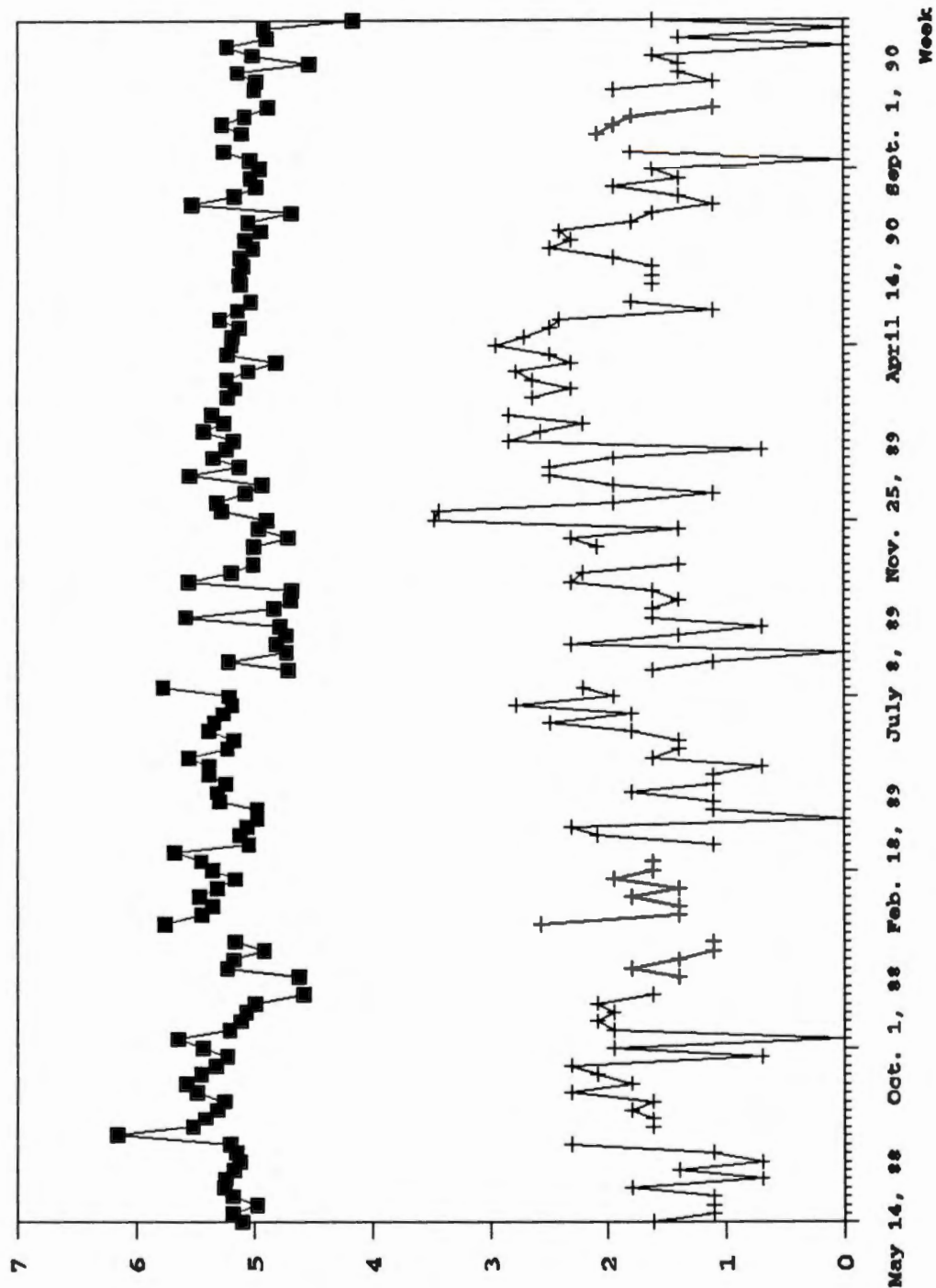


Figure 10. Natural Log of Cubed Steak Item Movement by Week.

series were labeled. Then, the peaks and troughs for each cut of steak were compared with respect to time. The timing of the turning points between the pairs for each cut were different, and there was no tendency for one series to lead or lag its counterpart.

Tray versus vacuum packed item movement correlations were calculated for each cut. The results are shown in Table 3. Filet mignon and cubed steaks have very small (in absolute value) correlations between package types. Vacuum and tray packed round steak moved in the same direction 60 percent of the time, and the corresponding value for the chuck steak is 44 percent. All the cross cut correlations are close to zero.

B. Advertising Data

The scan data are simply item movement and price records, they do not contain any information about advertising. Because the chain does not keep advertising records by bar code, the advertising data had to be gathered from other sources. Newspaper advertising was collected from a local paper. Television and radio advertising data were supplied by the chains' advertising agency.

There were several marketing/promotions that were not included in this study. They were the chains' own-cut, cross-cut, substitute, compliment and competitors' promotions. Own-cut promotions were not used because there were no brand coupons. Also, price specials applied to both tray and vacuum packed steaks. Cross-cut promotions would not affect the tray-vacuum packed trade-offs. Substitutes and complements also have no effect on the tray-vacuum packaging trade-offs. A chain's

Table 3.

Correlations Between Tray and Vacuum Steak Item Movement.

	Tray			Filet Mignon	Vacuum		
	Round	Chuck	Cubed		Round	Chuck	Cubed
Tray							
Filet Mignon	-.09	-.03	.09	-.10	-.02	.20	.03
Round		-.14	.07	.01	.60	-.09	.01
Chuck			.08	.09	-.11	.44	-.03
Cubed				-.03	.11	.08	.10
Vacuum							
Filet Mignon					.09	.26	.16
Round						.01	.06
Chuck							.06

competitors' promotions would not affect tray-vacuum packed trade-offs because most shoppers are store-loyal.

Newspaper advertising was collected mainly from a supplemental section in the Knoxville News Sentinel. Consumers were exposed to the same chain advertisements regardless of the store because all five stores are located in the Knoxville area. The following information was collected from the supplement for each cut included in the study: page, size, color, and week. Newspaper ads for the same cut of steak appeared on a single page or multiple pages. Tray and vacuum packed products were promoted together. Ads receive different amounts of exposure depending on the page on which they appear, so the pages were ranked from best to worst.

A color code was developed to denote whether color was used and whether the cut was advertised more than once in the supplement and newspaper. If there was no ad it received a color code of 0. A single black and white ad received a color code of 1, and single color ad received a color code of 2. If there was more than one black and white ad, it had a color code of 3. More than one color ad for a cut of steak received a color code of 4. A combination of black and white plus a color ad received a color code of 5.

Page and color were converted to an index (Eastwood, Gray, and Brooker). The index was used to order page and color combinations in accordance with increasing cost. This would permit an empirical test of the effect of more expensive newspaper advertising on item movement. The page on which the ad appeared is related to cost. Ads that appeared on the front or middle page had higher index numbers than the ads that

appeared on other pages because of more expensive layouts. Color also gave the ad a higher index number. The absence of an ad for a cut was coded as zero, and the most expensive had an index value of 23 (see Table 4). The ads were measured to determine their square inches.

Gross rating points were used for television and radio advertisements. These are numbers that were assigned to television and radio programs to reflect the size of the audience. If there was no advertising that week, gross rating points were zero. Only one cut, round steak, received any TV or radio advertising.

There was also a holiday variable included in the model. The reason these holidays were used was that consumers may eat more of these steaks during the holidays. The holidays used were Independence Day and Labor Day. Because consumers may purchase a week in advance, the week before the holiday was also coded as a holiday week. Holiday was set up as a dummy variable where 1 denoted the presence and 0 denoted the absence of the holiday weeks.

2. METHODOLOGY

In order to identify the demand curve, it is assumed that supply is perfectly elastic to the consumer. At a given price the consumer can purchase any amount of steak because supply is assumed to be unlimited for an individual consumer.

Table 4.

Index for Newspaper Advertising.

Page	Color Scheme ^a	Color Code ^b	Index
No ad	None	0	0
Regular paper only	B&W	1	1
		3	2
		5	3
Other supplement page only	B&W	1	4
		3	5
	C	2	6
		4	7
		5	8
Front, middle, last page only	B&W	1	9
		3	10
	C	2	11
		4	12
		5	13
Front, middle, last page only plus an other supplement page	B&W	1	14
		3	15
	C	2	16
		4	17
		5	18
Front plus middle of supplement	B&W	1	19
		3	20
	C	2	21
		4	22
		5	23

^a Defines whether the ad is color (C) or black and white (B&W).

^b The color code is 0=no ad, 1=single black and white ad, 2=single color ad, 3=more than one black and white ad, 4=more than one color ad 5=a combination of black and white plus a color ad.

The demand model developed in this study is based on the research described in Chapter II. The model is as follows:

$$Q_{i,t} = F(P_{i,t}, \text{Tray}_{i,t}, W_t, \text{Inter}_{i,t}, \text{Store}_t, H_t, \text{Ad1}_{i,t}, \text{Ad2}_{i,t}, \text{Ad3}_{i,t})$$

$Q_{i,t}$ - item movement for the i^{th} cut in week t .

$P_{i,t}$ - price of the i^{th} cut in week t (\$/lb).

$\text{Tray}_{i,t}$ - a dummy variable for cut i ($\text{Tray}_i=1$ if the steak is tray packed and 0 if vacuum packed).

W_t - is the week that sales occur.

$\text{Inter}_{i,t}$ - is the interaction between week and type of packaging in week t .

Store_t - a dummy variable for store ($\text{Store}=1$ if the store is one of the four high customer count outlets and $\text{store}=0$ if the store is the low number customer count outlet).

H_t - a binary variable for holiday ($H_t=1$ if week t contains a holiday, 0 otherwise).

$\text{Ad1}_{i,t}$ - square inches of the ad in the newspaper of cut i in week t .

$\text{Ad2}_{i,t}$ - indicates the index value for the ad for cut i in week t .

$\text{Ad3}_{i,t}$ - TV and radio advertising in gross rating points for cut i in week t .

3. COMMENTS ON VARIABLES

It is assumed that the demand equation is linear. With this assumption the explicit form of the demand equation is

$$Q_{i,t} = B_0 + B_1(P_{i,t}) + B_2(\text{Tray}_{i,t}) + B_3(W_t) + B_4(\text{Inter}_{i,t}) + B_5(\text{Store}_t) + B_6(H_t) + B_7(\text{Ad1}_{i,t}) + B_8(\text{Ad2}_{i,t}) + B_9(\text{Ad3}_{i,t}) + e_{i,t}$$

The own-price coefficient of the steak, B_1 , should be negative in order to be consistent with demand theory. The coefficient of Tray, B_2 , is expected to be positive. Item movements are higher when tray packaging is used. This is caused by the economics of information problem described in Chapter II. An insignificant coefficient would lead to the inference that alternative packaging types made no difference to the food shopper when making a choice within the cut. There is no a priori sign for the trend variable. A positive B_3 would mean that there is a rising trend of people eating more over of the specific cut of beef regardless of packaging over the time period. If the B_3 is negative, there is a trend of fewer people eating a specific cut of beef. The interaction term is to allow for different slopes of the vacuum versus tray packed steaks for each cut. If the coefficient is significant, then there is a difference in the slopes between the tray packaged and the vacuum packaged steaks. If the coefficients of Interaction and Tray are both positive (negative) and significant, then consumers are purchasing increasing (decreasing) amounts of the respective cut in tray packaging relative to vacuum. If the coefficient of Interaction is positive (negative) and significant and Tray is negative (positive) and significant, then there is a tendency for the two package series to converge (diverge) over time.

Following the results of other studies as presented in Chapter II, advertising has been shown to have a positive effect on sales of a good. Therefore, TV and newspaper advertising coefficients should be positive. This would indicate that as advertising for a cut increases so should item movement. The holiday coefficient should be positive. This would

indicate when there is a holiday item movement should increase, because people may consume more steak during these periods.

This model focuses on the demand for each cut of steak as a single equation. Several considerations led to the approach. The study is concerned with differences in the level of item movements of a specific cut, and packaging was the only difference. Any change in the price of a substitute or complement would not affect the tradeoff between the tray and vacuum packed choices of a given cut. For example, a change in the price of top sirloin steak would not affect the tradeoff between tray and vacuum packed round steak. Similarly, any other changes in the economic environment are assumed to have comparable impacts on tray and vacuum packed steaks. As a result, no other comparisons between the series were conducted. In addition, the item movement correlations shown in Table 3 are close to zero. This suggests the series are, at least on a pairwise basis, independent, so a seemingly unrelated regression format was not pursued.

CHAPTER IV

RESULTS AND CONCLUSION

1. RESULTS

The item movement model developed in Chapter III was estimated for each of the specific cuts of steak: filet mignon, round, chuck, and cubed. These four cuts of steak comprise a range of quality from prime to less tender pieces. Thus, the analyses cover a distribution of fresh beef steaks typically available in the meat department.

The overall F-value is used to test the null hypothesis that all coefficients are equal to zero. The alternative hypothesis is that at least one coefficient is not equal to zero. A five percent level of significance is used to test the null hypothesis.

The R^2 measures the proportion of the variation in the dependent variable explained by the variations in independent variables. It is a measure of the goodness of fit. The range of the R^2 is from zero to one. An R^2 equal to zero means the equation has explained none of the variation in the dependent variable. If the R^2 is one, the equation has explained all the variation in the dependent variable.

Estimated coefficients are estimates of the effects of the

respective independent variables on the dependent variable. Each coefficient is tested with a t-test at the 5 percent level of significance. The null hypothesis is that the respective variable has no effect on the dependent variable, or the population value of the coefficient is zero. If the computed coefficient is significantly different from zero, then the inference is that the independent variable explains some of the variance in the dependent variable, and the coefficient is the estimate of the effect.

The Durbin-Watson test for serial correlation was not used for two reasons. First, the data are pooled time-series and cross-section observations with missing weeks. The ordering of the data by store is arbitrary, so a reordering of the stores would produce a different Durbin-Watson. Second, the Durbin-Watson is generated by consecutive values. Within each stores' series for each cut, there are missing observations which decrease the number of sequential errors considerably.

A. Filet Mignon

The estimated equation is shown in the first column of Table 5. The F-test is significant at the 95 percent level, so the null hypothesis is rejected. The R^2 of this regression is .144, or the equation explains 14 percent of the variation in item movement. A low R^2 and a significant F indicate that, although a significant systematic relationship has been estimated, there is a relatively large random (unexplained) variation in the model.

Table 5.

Estimated Item Movement Equations by Type of Steak (Standard Errors in Parentheses).

Variable	Steak			
	Filet Mignon	Round	Chuck	Cubed
Constant	10.81*	229.25*	128.81*	33.83
	(2.76)	(27.65)	(9.25)	(41.75)
P	-.70*	-120.20*	-60.92*	-22.21
	(.28)	(10.87)	(3.55)	(14.64)
Tray	-.09	112.76*	24.00*	195.96*
	(1.45)	(11.87)	(4.83)	(9.10)
W	.04*	.50*	-.07	-.05
	(.01)	(.13)	(.06)	(.10)
Inter	-.02	-.29	.25*	-.36*
	(.02)	(.16)	(.07)	(.12)
Store	7.87*	40.54*	14.00*	51.00*
	(.80)	(7.25)	(2.88)	(5.35)
H	1.38	4.95	-7.44	-7.37
	(.80)	(10.15)	(3.85)	(7.17)
Ad1	-.41	5.10*	-3.13*	8.38
	(.54)	(.65)	(1.20)	(4.27)
Ad2	.02	2.06*	6.91*	-2.35
	(.33)	(.76)	(1.68)	(2.52)
Ad3		.02		
		(.04)		
F-Value	18.20*	167.65*	67.65*	216.29*
R ²	.144	.586	.384	.644

* Denotes that the F and t values are significant at the 95 percent level.

The coefficients of Tray, Inter, H, Ad1, and Ad2 are all nonsignificant at the 95 percent level which is consistent with Figures 3 and 7. The nonsignificance of the coefficient of Tray suggests there is no difference in the levels of the tray and vacuum packaged series. The tray and vacuum packed filet mignon series are not converging as indicated by the nonsignificance of the Tray and Inter coefficients. The nonsignificance of the H coefficient leads to the inference that H has no effect on item movement. Also, the nonsignificance of Ad1 and Ad2 leads to the conclusion that advertising has no effect on item movement.

The intercept of 10.81 is significant at the 5 percent level. It suggests that eleven items are sold, on average, without accounting for any of the independent variables included in the equation. The coefficient of P, the price of filet mignon, is $-.70$ and significant. This sign is consistent with demand theory. If the price of filet mignon goes up by one dollar, the sales of filet mignon will decrease by one item. An own-price elasticity of $-.567$, calculated at the sample means, implies that as the price of filet mignon is changed by one percent, the item movement will change by $.567$ percent in the opposite direction. The coefficient of W, $.04$, is significant. After 25 weeks pass there is estimated to be an increase of one package sold per week. This is a very slight positive trend overall which indicates that food shoppers as a group are consuming slightly more filet mignon each week. The significant coefficient of store is 7.87 . It suggests that if the store is highly patronized then there would be eight more items sold over a low volume store.

With respect to consumer acceptance of vacuum packaging, these results suggest a fairly high level of market penetration for this cut. The insignificance of the Tray and Inter coefficients leads to the inference that there is no significant difference in the levels of item movement between the two types of packaging. Furthermore, there is no evidence that the series are diverging. An interpretation is that vacuum packaging has reached an acceptance rate of approximately half of the filet mignon sales, but the level of penetration has not changed over the May 14, 1988 to December 31, 1990.

B. Round Steak

The estimated equation is shown in the second column of Table 5. The F-test is significant at the 95 percent level, so the null hypothesis is rejected. The R^2 of this regression is .586, or the equation is explaining 59 percent of the variation in sales. This is fairly high given the variation in the plots seen in Figures 4 and 8.

The coefficients of Inter, H, and Ad3 are all nonsignificant at the 5 percent level. This is consistent with Figures 4 and 8. The tray and vacuum packed series seemed to be parallel, and this is consistent with the insignificance of the inter coefficient. The nonsignificant H coefficient leads to the inference that item movement is not effected by Independence Day or Labor Day holidays. The nonsignificant Ad3 suggests that radio and television advertising do not effect item movement.

The following coefficients were significant at the 5 percent level: Intercept, P, Tray, W, Store, Ad1, Ad2. The intercept was 229.25. This suggests that 230 items are sold, on average, without

accounting for any of the independent variables included in the equation. The coefficient of P , the price of round steak, is -120.20. If the price of round steak goes up by one dollar, the sales of round steak are expected to decrease by 121 items. This is consistent with demand theory. An own-price elasticity of -3.417 implies that as the price of round steak is changed by one percent, the item movement would change by 3.417 percent in the opposite direction. The coefficient of Tray is 112.76. This indicates that if the item is tray packed there should be an increase in sales of round steak by 113 items over the vacuum packed product. The coefficient of W is .5. After two weeks have elapsed there should be an increase of one package sold per week. This suggests a positive trend of people consuming more round steak each week. The coefficient of store is 40.54. If the store is highly used by consumers, there will be an increase in item movement of 41 items is predicted. The coefficient of Ad_1 , size of an ad, is 5.10. When the size of an ad is increased by one square inch, there is estimated to be an increase of 6 items sold that week. The sign does make sense, a bigger ad should be noticed more, and therefore, increase sales. The coefficient of Ad_2 , index of an ad, was 2.06. This indicates that as newspaper advertising of round steak increases from one index category to the next, item movement should increase by just over two packages. This sign also makes sense, because as the cost of an ad goes up there is greater exposure of the product.

Estimates of the round steak equation suggest that the item movement is responsive to price changes. It also leads to the conclusion that consumers of round steak are much less likely to

purchase the vacuum packed product. This indicates there may be information and experience good problems with the vacuum packed round steak. The results also reveal a statistically significant trend of increased consumption.

C. Chuck Steak

The estimated equation is displayed in the third column of Table 5. The F-test is significant at the 5 percent level, so the null hypothesis is rejected. The R^2 of this regression is .384, which indicates the equation explains 38 percent of the variation in sales.

The coefficients of W and H are nonsignificant at the 5 percent level. There is no significant trend. Also the holidays have no effect on item movement.

The intercept, P, Tray, Inter, Ad1, and Ad2 were significant at the 5 percent level. The intercept was 128.81. This suggests that 129 items are sold, on average, without accounting for any of the independent variables included in the equation. The coefficient of P, the price of chuck steak, is consistent with demand theory. If the price of chuck steak goes up by one dollar, the sales of chuck steak should decrease by 61 items. An own-price elasticity of -5.47 implies that, if the price of chuck steak is changed by one percent, the item movement will change on average by 5.47 percent in the opposite direction. The coefficient of Tray is 24. If the item is tray packed, there should be an increase in sales of chuck steak by 24 items. The coefficient of Inter is .25. This means that slopes of tray and vacuum packed chuck steak are different and moving away from each other. The

coefficient of store is significant, this indicates the higher volume stores typically sold 14 more packages than the lower volume supermarket.

The coefficient of Ad_1 is -3.13. As the size of the ad increases by one inch, a decrease of 4 items is predicted to occur. The smaller the ad, the greater the chuck steak item movement. This counter intuitive result prompted some additional analysis. To see if there is any unusual price or advertising relationship for chuck steak versus the other cuts, correlations between prices and the advertising indices were calculated. The results are displayed in Table 6. Inspection of the table indicates that the cross-price correlations are fairly close to zero. More importantly, those for chuck steak do not appear to be markedly different from the others. This suggests that the values of the estimated Ad_1 coefficient is not due to the change in the prices of the other cuts that are also vacuum packed. Similarly, the correlations of prices and the newspaper advertising indices do not point to any pairwise values that would indicate that chuck steak is promoted differently from the other cuts.

Another possibility is that the size of the chuck steak newspaper ads are different from those of the other cuts. Table 7 presents correlations between prices and the size of newspaper ads. These are also close to zero. The chuck steak correlations do not stand out as being particularly different from those for the other cuts. This is another indication that the significant negative Ad_1 coefficient in the chuck steak equation is not due to the promotions or the pricing of the other cuts when chuck steak is advertised.

Table 6.

Correlations Between Steak Prices and Advertising Indices.

	Price			Ad2 (Index)			
	Round	Chuck	Cubed	Filet Mignon	Round	Chuck	Cubed
Price							
Filet Mignon	-.05	.24	.11	-.11	-.05	-.13	-.02
Round		.12	.17	-.08	-.45	.08	.01
Chuck			.21	-.01	.05	-.43	.08
Cubed				.01	-.13	.08	-.28
Ad2 (Index)							
Filet Mignon					.10	-.08	-.01
Round						-.09	.16
Chuck							-.07

Table 7.

Correlations Between Steak Prices and Space of the Ads.

	Price			Adl (Space)			
	Round	Chuck	Cubed	Filet Mignon	Round	Chuck	Cubed
Price							
Filet Mignon	-.05	.24	.11	-.05	-.03	-.14	-.02
Round		.12	.17	-.08	-.56	.05	-.01
Chuck			.21	-.02	.03	-.44	.02
Cubed				-.11	-.07	.08	-.43
Adl (Space)							
Filet Mignon					.14	-.06	.04
Round						-.08	.01
Chuck							-.06

The counterintuitive result may be due to the very low levels of chuck promotions in the newspaper. Table 8 presents the mean price, advertising index and space variables for the four cuts of steak. The mean value for chuck Ad2 is .54, and the next larger one is .79. However, the average size of the chuck ads (Ad1) is larger than those for filet mignon and cubed steak (.71 versus .37 and .45, respectively). This suggests that, although the average size of chuck steak ads is above those for filet mignon and cubed steaks the chain tends not to use multiple or color ads vis-a-vis the other cuts. Such a pattern of chuck steak advertising could lead to the significant negative coefficient of Ad1 in the chuck steak equation.

The coefficient of Ad2, index of an ad, is 6.91. As the cost of the ad increases, seven more items are predicted to be sold per week. This sign is expected. As the cost of an ad goes up, it has better exposure hence increased sales.

The estimated equation for chuck steak generated an own-price response that is elastic. The estimated Tray coefficient suggests that consumers prefer tray packaging for chuck steak. The different estimated coefficients for Tray and Inter indicate that tray and vacuum packed steaks series are diverging. No significant trend for this cut of steak is found.

D. Cubed Steak

The estimated equation is shown in the fourth column of Table 5. The F-test is significant at the 5 percent level, so the null hypothesis is rejected. The R^2 for this regression is .644, or the equation

Table 8.

Means for Price, Space, and Index.

Steak	P (Price)	Ad1 (Space)	Ad2 (Index)
Filet Mignon	11.15	.37	.82
Round	2.56	4.04	2.47
Chuck	2.37	.71	.54
Cubed	2.91	.45	.79

explains nearly 65 percent of the variation in sales. This R^2 is fairly high, given the dispersion within each series shown in Figures 6 and 10.

The intercept is nonsignificant at the 5 percent level. The P, W, H, and Ad2 coefficients are insignificant at the 5 percent level. The nonsignificance of the P coefficient leads to the inference that price has no effect on item movement for cubed steak. This means the item movement is not responsive to changes in its own-price. Also, the nonsignificance of W is an indication that there is no increase or decrease of item movement for cubed steak over time. The nonsignificance of the H coefficient shows that the holiday measure has no effect on item movement. The insignificant Ad2 coefficient suggests that multiple or color ads have no effect on item movement.

The coefficients Tray, Inter, and Store are significant at the 5 percent level. The coefficient of Tray is 195.96. When the item is tray packed, there is a predicted increase in sales of cubed steak of 196 items. This also makes sense because Figures 6 and 10 show a large difference in the levels of item movement between the vacuum and tray packed cubed steak. The coefficient of Inter is $-.36$. This means the slope of tray packaged cubed steak series is converging on the slope of vacuum packaged cubed steak series given the Tray coefficient. This trend is visible in Figure 6. The coefficient of store is 51. This means that, if the store is highly visited, there is an expected increase in item movement of 51 items.

This equation suggests that price has no measurable effect on cubed steak item movement. It also indicates that the type of packaging used makes a difference. Tray packaging has significantly higher item

movement. The significance Tray and Inter coefficient suggest the tray and vacuum cubed steak series are converging.

2. CONCLUSION

The intercepts of filet mignon, round steak, and chuck steak are significant and positive. This is expected. Filet mignon's intercept is the smallest, which is consistent with it having the lowest weekly item movement of the four steaks. Filet mignon is the highest priced steak of the four analyzed (see Table 8). Its average price of \$11.17 per pound is nearly four times those of the other cuts when ranked by the quality of the cut.

The price coefficients are all negative, and all but one is significant at the 5 percent level. This is consistent with demand theory. More importantly, the own-price elasticity results are consistent with the ranking of steaks on the basis of quality. Own-price elasticities measure consumer responses to demand due to changes in the price of that good. The more negative an own-price elasticity, the greater the consumer responsiveness to own-price changes. One of the major reasons for own-price sensitivity is the availability of substitutes. The reason is that consumers have the option to switch to substitutes when the own-price rises.

The estimated own-price elasticities reflect these market substitution conditions for the four cuts of steak. Filet mignon is very inelastic. Those who buy this cut tend to be less price sensitive because filet mignon is much more expensive than the other steaks, and it has few substitutes. Those consumers who purchase this high quality

cut of steak are less concerned with the price than the food shoppers who typically buy the other cuts. The estimated round steak elasticity is elastic, and chuck steak's estimate is even more elastic. This suggests that consumers are more responsive to changes in price with the lower price steak, such as round or chuck steak, because not only are round and chuck steaks substitutes for each other, but there are other steak cuts having comparable prices and quality. The insignificance of the cubed steak price coefficient may reflect food shoppers treating this cut as a residual, only to be purchased when the prices of other steaks preclude their being purchased.

The trend coefficients are positive and significant in the filet mignon and round steak equations. They indicate that people are consuming slightly more of these tray and vacuum packed steaks over time. Neither chuck nor cubed steak have significant trends.

Holiday is nonsignificant in all of the estimated equations. This leads to the conclusion that these measured holidays having no effect on item movement for any of the given steaks. Neither Labor Day nor Independence Day are associated with higher steak sales.

Advertising's effects are mixed. The size of the ad is positive and significant in the round steak equation, whereas it is negative and significant in chuck steak equation. With respect to round steak, item movement increases as size increases. A negative and significant size effect is found for chuck steak. Part of the reason for the newspaper advertising results is the frequency with which the chain advertised the various cuts. Almost all of this advertising is for round steak, so there are many more nonzero observations for estimating the impacts for

this cut. Television advertising is only used for round steak. It is found to be insignificant. This may be a result of too few observations to measure an effect statistically. A suggestion for further study is to design an experiment to study the effect of advertising on beef sales.

The Tray variable had positive and significant coefficients in three of the four estimated equations. The exception was filet mignon. An implication is that for most cuts of steak food shoppers prefer the traditional packaging to vacuum packaging when these two alternatives are available at the same price per pound. This is consistent with the economics of information problem described in Chapter II. There has been very little explanation of vacuum packaged beef products in the Knoxville area. Consequently, food shoppers are confronted with new beef products for sale at the same prices per pound as the respective tray packed cuts. The color of the beef in the vacuum packages is one that is associated with spoiled beef. Given the information void, consumers have little reason to purchase vacuum packed beef.

One of the main problems with vacuum packed steaks is the lack of information. As shown in Figures 3 and 7 and the respective estimated equations, this problem does not exist with filet mignon. The two series overlap, and the Tray and Inter coefficients are insignificant. It may be the consumer purchasing this luxury good is more willing and able to take the risk associated with this experience good. However, the beef industry cannot rely on filet mignon sales to either generate enough sales to justify the investment in the equipment or to serve as an information vehicle to reach most consumers.

Consequently, the beef industry faces an information problem that is difficult to address because of a free-rider potential. The problem is that if one, or a few, packers go to the expense of educating consumers about the color of vacuum packed beef, and thereby create a market, other packers could then enter the market without having incurred the promotional costs. This is because the technology is available to the industry. In fact, the chain in this particular study has decided to discontinue vacuum packed beef. The decision was based, in part, on the low level of sales and no evidence of growing consumer acceptance.

Results of this study indicate significantly lower levels of product movement for the vacuum packed beef in three of the four instances, and the exception is for a relatively limited product. More importantly, there is no evidence that the experience good and color information problems are being eliminated. A direct implication is that it may be necessary for the beef industry to develop its own educational and promotional programs to foster consumer acceptance. This would address the free rider problem as well as provide consumers with an easier to handle product and supermarkets with cost savings.

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