

# **Income Elasticities for Beef, Pork, and Poultry: Changes and Implications**

by

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## **Introduction**

Relationships between quantities demanded for beef, pork, and poultry have received much attention in recent years. Two questions are commonly addressed in the literature: (1) whether the quantities demanded for these meat products are becoming less responsive to changes in income and prices and (2) whether there has been a structural change in the demand for meat and meat products.[1] Our purpose here is to examine the framework within which these analyses are often conducted and suggest an alternative estimation approach which will provide insight into the changes in income and price responses over time. For ease of exposition, the presentation will focus on changes in relationships between income and meat consumption.

The paper is organized as follows. The next section presents a brief discussion of the problem and its importance to the meat production and distribution industries. The objectives of the analysis are presented in the third section of the paper. The fourth section of the paper presents a brief conceptual note regarding the analysis. The methods used in the study are summarized in section five. Section six presents the results and conclusions of the study. The paper concludes

with a brief discussion of implications for the food distribution industry, including suggestions for further research.

## **The Problem**

After a period of significant growth during the 1960s and early 1970s, the demand for red meat, particularly beef, has slipped dramatically as we move into the 1980s. Consumers are purchasing beef and pork only at lower real prices and substituting other products, including poultry, into the dietary slot which red meat formerly occupied. Raunikaar, Huang, and Purcell have suggested that population effects, income effects, diet and health effects, and social pattern effects are among the primary factors affecting these changes in the U.S. food markets. In the face of a shrinking market share, the red meat industry is seeking ways to curtail, and, if possible, reverse the decline. As a result, increased interest has surfaced in recent years in identification of how meat consumption responds to changes in income and price.

Research into the responsiveness of red meat consumption to changes in income and prices, however, has tended to focus on identification of a specific point of structural change. From the standpoint of the

industry, a more useful approach may be to examine how the income and price responses have changed through time. An analysis of the changes in relationships between consumption and income over time will provide valuable insight to those involved in the red meat distribution industry in: (1) identifying where demand will move in the future and how rapidly changes will occur and (2) in identifying the appropriate market segments for promotional efforts.

### Objectives

The general objective of this paper is to examine changes in the relationship between meat consumption and income over the period from 1960 through 1983.[2] More specific objectives include:

1. To present conceptual arguments for the examination of changes in income and consumption relationships over time rather than in a static point of structural change context.
2. To estimate income elasticities for beef, pork, and broilers using a "moving data" technique to illustrate changes in income and consumption relationships over time.
3. Draw inferences regarding changes in the estimated income elasticities of demand, to offer suggestions for further research, and to the implications of the results for the food industry.

### A Conceptual Note

Investigators of the response of meat consumption to changes in incomes and prices tend to concentrate on identifying a static point of structural change. We argue, however, that tastes and preferences change slowly over time and therefore attempts to isolate a specific point where the structure of demand changed will actually identify the point where the changes over time became significant in an aggregate sense. Further, such analyses will tend to be time period sensitive in that the results may differ in significance, depending on how the subperiods are defined.

Examining changes in consumption and income relationships in a more dynamic framework will provide important insight into the speed with which changes in the demand for meat have occurred. Unlike structural change types of analyses, the proposed dynamic framework will provide for an assessment of whether continued change can be expected or whether the decline has leveled off. Finally, insight can be gained which will aid the industry in developing targeted promotional efforts for red meats.

### Summary of Methods

The responsiveness of beef, pork and poultry consumption over time was examined by estimating a single equation demand model for each commodity. The model:

$$Q = f(\text{PBF}, \text{PPK}, \text{PBR}, Y, D)$$

where

Q = quarterly per capita consumption (beef, pork, poultry in the respective equations) in pounds per unit of time

PBF = deflated[3] retail price of beef in cents per pound

PPK = deflated retail price of pork in cents per pound

PBR = deflated retail price of broilers in cents per pound

Y = deflated disposable income per capita in dollars per person

D = a set of three 0, 1 dummy variables to account for variations in mean consumption levels each quarter

was fitted to quarterly data for the period January 1960 through December 1983. To facilitate examination of responses through time, two moving data period analyses were performed.

First, the data set was divided into six-year subperiods on an annual basis.[4] Each subperiod consisted of twenty-four quarterly observations. For example, the first sub-

period covered the first quarter of 1960 through the fourth quarter of 1965, the second subperiod covered the first quarter of 1961 through the fourth quarter of 1966, and so forth. The above model was estimated for each of the resulting 18 subperiods and for the entire data period.

Second, the data set was divided into six-year subperiods on a quarter by quarter basis. The first subperiod covered the first quarter of 1960 through the fourth quarter of 1965, the second covered the second quarter of 1960 through the first quarter of 1965, the third covered the third quarter 1960 through the second quarter of 1965, and so forth.

All models were estimated using ordinary least squares (OLS) methods on natural logarithms of the data. Diagnostic checks for collinearity indicated no problems with linear associations between the independent variables. Serial correlation was a problem in all of the OLS models, as indicated by the Durbin-Watson statistic. An autoregressive correction procedure was therefore applied to all models. The results reported below derive from the corrected models.

## Results and Conclusions

The results of the six-year annual moving period estimations of income elasticities across the time period from 1960 to 1983 are summarized in Table 1. The income elasticity estimates for beef become negative during the mid-1970s and continue negative into the 1980s. All but five of the subperiod elasticity estimates for beef are significantly different from zero at the .05 level. The estimated subperiod elasticities for pork tend to be negative throughout the period, although only four are significantly different from zero at the .05 level. The estimated subperiod income elasticities for broilers are all positive and significantly different from zero at the .05 level.

The estimated income elasticities for the entire data period are also reported in Table 1. All are significantly different from zero at the .05 level. It is interesting to note that the income elasticity for pork is

negative when estimated across the entire period, suggesting that pork was an inferior good during the period. That is, as incomes rose, consumption of pork declined. The estimated elasticities for beef and poultry each indicate normal good relationships, i.e., as incomes increase so does consumption of beef and poultry.

Figure 1 presents the results of the quarterly moving model estimations in graphical form. The behavior of the estimates across time is interesting. There is a clear contrast in the time paths of the estimated elasticities for beef and pork when compared to the estimated elasticities for poultry, particularly late in the data period. Consistent with the results presented in Table 1, the estimated elasticities for beef and pork become negative in the mid 1960s and continue negative into the 1980s. In contrast, the estimated elasticities for broilers tend to increase during this period.

When combined with the results in Table 1, Figure 1 supports an argument that red meat consumption (beef and pork in this case) has become less responsive to changes in income in recent years. Poultry consumption, on the other hand, appears to have become more responsive.

The results of the above analysis of relationships between income and meat consumption over time support the following conclusions:

1. Changes in income elasticities for beef, pork, and broilers have occurred gradually over time during the period 1960 through 1983. The results presented here suggest that the income elasticities are not static. This result suggests that additional thought should be given to the potential aggregation bias in models designed to capture structural demand changes at a specific point in time.
2. The income elasticity for beef appears to have become negative in recent years, suggesting that demand responses will no longer come from income increases. This conclusion, however, must be tempered by the realities of income distributions in

**Table 1**  
**Estimated Income Elasticities for Beef, Pork and Poultry**  
**From an Annual Moving Data Model for Six-Year Subperiods**  
**From January 1960 through December 1983**

Time Period	----- Commodity -----		
	Beef	Pork	Poultry
	Elasticity Estimate/(P-value)		
1960-65	1.268*	-0.274	0.642*
1961-66	1.307*	-0.185	0.761*
1962-67	1.412*	0.044	0.777*
1963-68	1.079*	0.271*	0.882*
1964-69	0.834*	0.447*	1.229*
1965-70	0.901*	0.591*	1.599*
1966-71	1.128*	-0.343	2.221*
1967-72	0.755*	-0.357	1.896*
1968-73	0.242	-0.122	1.966*
1969-74	0.636*	-0.183	1.276*
1970-75	0.808*	-0.236	0.674
1971-76	0.042	0.714	0.633
1972-77	-0.059	-0.019	0.721*
1973-78	-0.452*	-0.395	1.806*
1974-79	-0.321	-0.707	1.734*
1975-80	-0.156	-0.259	1.535*
1976-81	-0.976*	-0.706*	1.904*
1977-82	-1.056*	-0.637	2.254*
1978-83	-0.864	0.182	1.531*
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1960-83	0.447*	-0.244*	1.422*

\* Significantly different from zero at the .05 level.

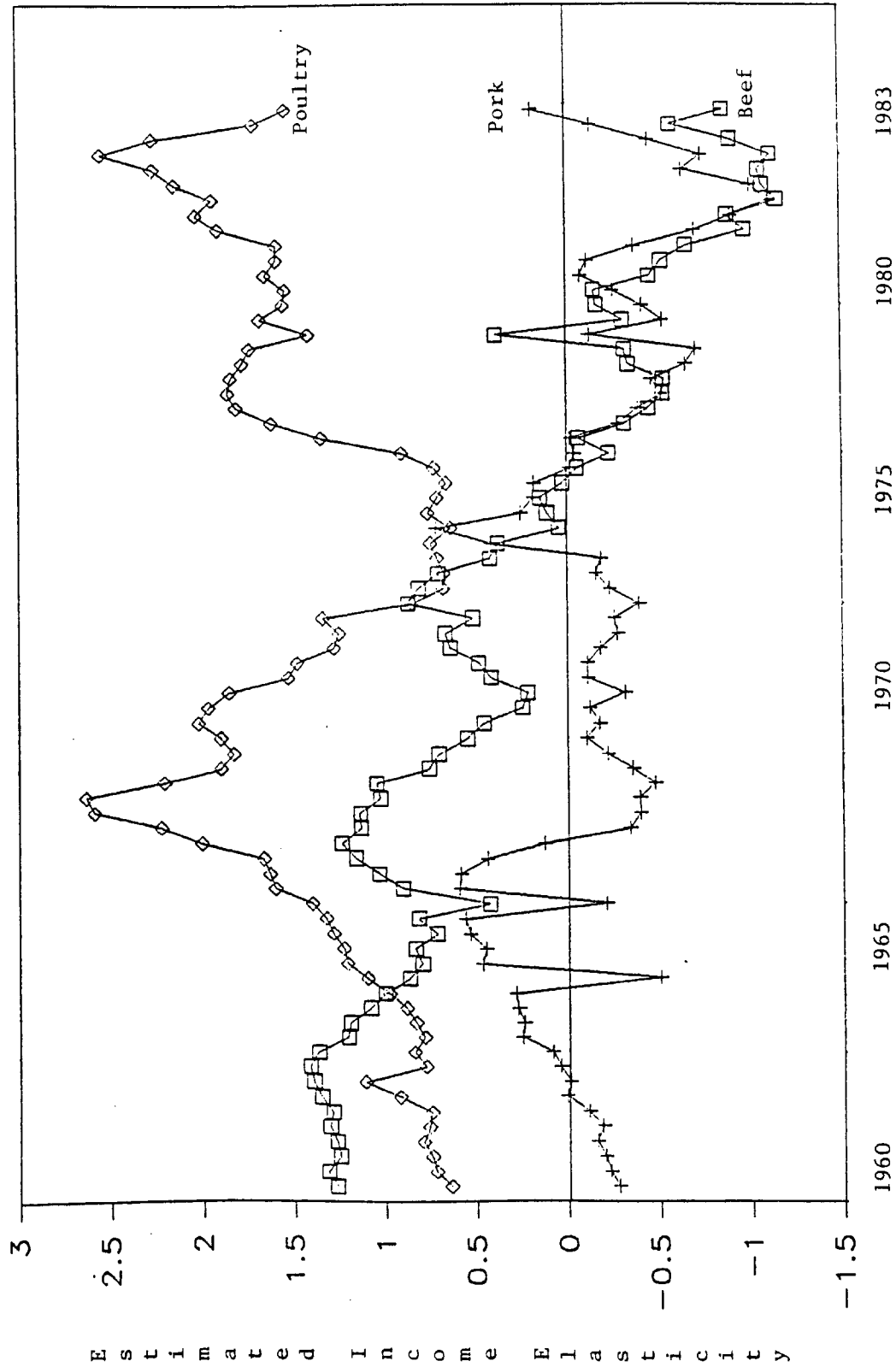


FIGURE 1. PLOT OF ESTIMATED INCOME ELASTICITIES FOR BEEF, PORK, AND POULTRY USING A QUARTERLY MOVING MODEL FOR SIX YEAR SUBPERIODS FROM JANUARY 1960 THROUGH DECEMBER 1983.

the United States. The argument can readily be advanced that, although in the aggregate sense beef demand is no longer responsive to income increases, the response for some income groups is likely to be significant and positive.

3. The income elasticity for pork appears to have become negative during recent years and in most cases is not significantly different from zero. When aggregated across the entire data period, the estimated income elasticity for pork is also negative. In short, this result suggests that pork is viewed as an inferior good in the aggregate and that demand is not likely to increase significantly due to income increases. Similar to beef, there is likely to be a difference in the response across various income groups.
4. The income elasticity for poultry is positive throughout the data period. This may, however, be reflecting other factors, including diet and health concerns, an increased demand for convenient "quick-fix" products, many of which contain poultry, and/or increased incidence of eating outside of the home.

### Implications

The results presented above have important implications for producers, processors, distributors, and analysts involved in the red meat industry, including:

1. There is clearly a need for further research efforts which examine quantity responses to changes in incomes and prices within specific income distribution groups. Specifically, research efforts need to address the differences in response within and across various income groups. Data is clearly the main limitation to further research efforts in this area. The results here suggest that every effort should be made to increase the availability and quality of data on income distribution and consumption.
2. Industry promotional efforts need to be directed at the population segments that will respond. For example, if incomes

are expected to increase during a certain period of time, then promotional efforts for meats should be targeted to the groups who will spend a portion of the income increase on meat and to the specific products which they will purchase.

3. Industry analysts involved in projecting prices and/or supplies need to consider the changes over time in income elasticities. The results presented herein suggest that red meat production should not be increased in response to expected income increases. The same line of reasoning would apply at the wholesale or retail level of the system.
4. Finally, the use of a moving data period type of estimation procedure to examine changes in income and price elasticities shows promise and should receive additional attention. The use of such data series with more complex models which will provide and utilize additional information should be explored. There are also other approaches to examining the time paths of changes in variables which should be considered.

### Endnotes

- [1] The literature on this subject is vast and a formal review will not be attempted here. The interested reader is directed to the works of Braschler, Chavas, and Leuthold and Nwagbo for more complete summaries of the literature.
- [2] Changes in relationships between meat consumption and prices will not be addressed here due to space limitations. A complete discussion of these relationships can be found in Hudson and Vertin.
- [3] All deflation was done using the Implicit GNP Deflator.
- [4] Moving subperiods of 5, 8, and 10 years were also examined. The results for these periods were similar to those reported below for the six-year periods. A complete set of results is available from the authors.

## References

- Braschler, C. "The Changing Demand Structure for Pork and Beef in the 1970s: Implications for the 1980s." Southern Journal of Agricultural Economics, 1983 (December): 105-109.
- Chavas, J. P. "Structural Change in the Demand for Meat." American Journal of Agricultural Economics, 65 (1983): 148-153.
- Hudson, Michael A., and Joseph P. Vertin. "Income and Price Elasticities for Meats: Changes Over Time." University of Illinois, Department of Agricultural Economics, mimeo.
- Leuthold, R. M. and E. Nwagbo. "Changes in the Retail Elasticities of Demand for Beef, Pork, and Broilers." Illinois Agricultural Economics, 1977 (July): 22-27.
- Purcell, J. C. "Food Demand Analysis: Discussion." Paper presented at the S-165 Symposium, Biloxi, Mississippi, February, 1985.
- Raunikar, R., C. L. Huang, and J. C. Purcell. "The Changing United States Food Market." Journal of Agribusiness, 1985 (February): 42-45.