Structural Change in Meat Demand: The End of the "Chicken Little" Era

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Introduction

Meat consumption patterns have changed in the United States. A cursory inspection of the disappearance statistics for meat in the United States reveals that generally, the consumption of red meats has decreased or remained constant while the consumption of poultry and other meats has increased. Economists have had only modest success in developing cogent explanations for these changed consumption patterns, and a "chicken little" psychology has come to dominate much of the recent discourse. Arguments, for the most part not based on demand theory, have been put forth that recent consumption changes cannot be explained by relative prices, income, and simple demographic effects. Conjecture about lifestyles, health concerns, consumer attitudes toward red meats, and other factors suggest implicit prophesy of doom for the beef industry. Systematic analyses of consumption changes and assessments of the theory are needed to address these largely unsupported suppositions.

Fortunately, the chicken little era is coming to an end as more careful economic theory is being applied. This symposium will conclude that most of the variation in consumption can be explained by applications of conventional demand analysis methods. From these applications, constructive suggestions for extensions of consumer demand theory will evolve. We understand much more about meat consumption patterns than at least the popular wisdom suggests. The demand systems approach that has governed good empirical demand work since Henry Schultz nearly 50 years ago still applies.

The comments on the four papers of this session are organized as follows. A few general observations on the structure of the demand for meat are made in the following section. These are motivated by the background and overview papers and by recent empirical analyses of the consumer demand for meat. Next, comments specific to the four papers are presented. The intent of the comments is to summarize the major conclusions for the structure of meat demand and to evaluate the estimated price and income effects. A few observations are also made on the methods utilized. Approaches not anticipated by these papers then are suggested for studying changed meat consumption patterns. The final section offers speculations on productive areas for additional research.

Structural Change of Meat Demand

The concept of structural change, particularly as applied in the empirical analysis of changed meat consumption patterns, has proven elusive. This problem is well documented in the previous session by Chavas (1986) and Haidacher et al. (1986). Careful scrutiny of past studies of structural change leads to the conclusion that without a well-developed, maintained hypothesis the results are largely vacuous. For example, if an ad hoc specification for retail meat demand that worked well in the late 1960s and early 1970s suddenly does not work well in the late 1970s and early 1980s, the only implication is that the equation does not explain the more recent data very well. Leaping to the conclusion that the structure for the demand of red meat has changed is to draw a completely unsupported inference from the results. The chicken little syndrome seems to have evolved largely from such misinterpretations of empirical results from applications of ad hoc demand functions.

Data and Preferences

If we adhere to static demand theory, possibilities for structural change are limited. The two major alternatives are the data and the preferences of consumers and/or households. For the data, the variables used to measure consumption, price, and income may require reexamination.

Convenience foods, changes in the product, evolving composition of the population, and modifications in price indices are examples of factors that can alter demand parameter estimates. The implication is that great care must be taken in understanding the data used. Frequently, demand parameter estimates interpreted as suggesting structural change can be explained by changes in the data and associated model misspecifications. The earlier papers by Buse (1986), Nelson and Duewer (1986), and Schrimper (1986) highlight problems in the data available for applied demand analysis.

The second possibility for structural change is changed preferences. Hypotheses of changed preferences are, however, difficult to implement empirically. Changes can, for example, be rationalized on the basis of household versus individual decision models, household production hypotheses, uncertainty, etc. The observations of Chavas (1986), drawing the parallel between technology change in production function estimation, and changed preferences in demand systems estimation, are useful. The uncertainty and risk preferences of consumers provide another possibility for rationalizing changes in parameter estimates (Choi et al., 1986). Of course, these hypotheses for changes of preferences must be evaluated empirically. The point is that they offer constructive hypotheses for explaining preference changes. Without this added structure, results of empirical work on changes in preferences is of little value theoretically or for policy and decision analysis.

Empirical Demand Systems

Applications of the theory in empirical analysis of the demand can be viewed as occurring in the four eras shown in Figure 1. First, there was the work of Schultz (1938) and his contemporaries. In that era, the implications of the standard theory of consumer demand for estimated demand systems were fully developed. Associated empirical work was limited, however, by available estimation methods.

The next era in applied demand systems analysis was stimulated by Frisch (1959) and involved the work of Brandow (1961), George and King (1971), and Hassan and Johnson (1976). Available price and income elasticity estimates were used in constructing full demand systems. Subsequent assessments have shown that for these systems, the empirical and prior information was not sufficient to identify all the parameters. Thus, advertently or inadvertently, a good deal of judgment has been applied in the construction of the full demand systems. And yet, the demand parameters from these full studies have continued to be used in applied work for almost 20 years as reference or baseline estimates.

The third era is identified with full demand systems approaches that, again in the spirit of Frisch, economize on the number of parameters to be estimated. These approaches (e.g., linear expenditure, extended linear expenditure, indirect addilog, Almost Ideal Demand Systems, translog, and others), by adopting appropriate functional forms, limit the number of parameters necessary for estimating complete demand systems (Deaton and Muellbauer, 1980; Gorman, 1976; Johnson et al., 1984). The behavioral implications of limiting the parameters required to define full demand systems are high, however. Assumptions restricting substitution of responses to relative price changes and price relative to income responses are introduced. This feature of the demand systems (called separability), narrowing the preference structures they can represent, is especially troublesome for applications with disaggregated commodity groups. For disaggregated commodity groups, cross price elasticities are key parameters. But, strong restrictions on the estimated cross price elasticities are introduced by the previously mentioned systems. Results from applications of these demand systems provide perspective on the empirical implications of the restrictions (Blanciforti and Green, 1983; Brown et al., 1985) but are not well suited for policy and decision analysis.

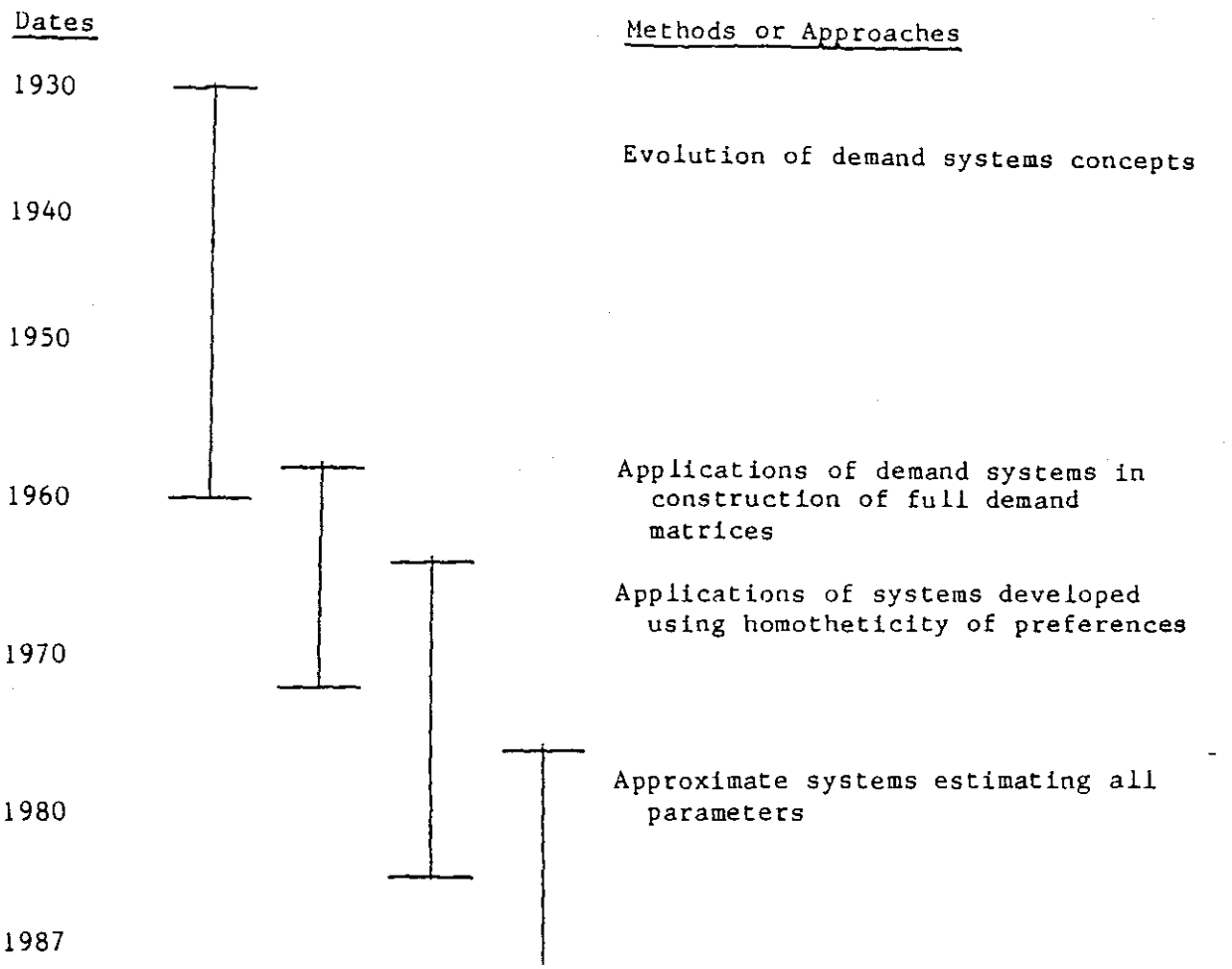

Figure 1. Modern Applied Demand Analysis, A Temporal Perspective.

During this era, the restrictions necessary for the individual or household theory to carry over to data observed at the market level were more completely developed (Diewart, 1980; Eisenberg, 1961; Muellbauer, 1976; and Sonnenchein, 1973a,b). These restrictions proved to be very strong and, in addition to estimation advantages, were equally important in motivating the development of the limited parameter demand systems of this era. Most of these systems, perhaps with added but modest restrictions, assure a correspondence between the implications of the consumer theory at the individual and market levels. That is, they assure that the restrictions introduced are appropriate in the market or aggregate data.

An alternative to using more generally available market-level time series is to estimate demand systems from cross section data. Again, unfortunately there are problems for generalization to market implications. If single cross sections are used, either price impacts must be inferred from demographic and socioeconomic impacts (Green et al., 1979; Howe, 1977; Lluch et al., 1977) or it must be assumed that there is sufficient valuation observed in prices (not due, for example, to quality change) to estimate the system parameters (Ray, 1980; Teklu and Johnson, 1987). The aggregation problem remains, however, even when abstracting from these problems. Without extensive incorporation of socioeconomic and demographic parameters and information on how the underlying characteristics of households/individuals are changing, the aggregate or market level parameters necessary for much of the consumption and price policy analysis cannot be deduced from these results.

The fourth era, currently unfolding, can be viewed as an extension of the early work by Brandow and his contemporaries. Here, the restrictions from the theory are more systematically merged with the data than in the earlier era. This approach has been made available by developments in computer technology, permitting the solution of large restricted least squares, Bayesian, and mixed estimation problems. Examples of work applying this approach for demand systems estimation include Huang, 1985; Huang and Haidacher, 1983; Taylor et al., 1986; Theil et al., 1985; Safyurtlu et al., 1986; Pope et al., 1980; Chavas, 1983; Barten, 1967; Byron, 1970; and Capps and Havlicek, 1984. These studies have estimated more disaggregated demand systems and demand systems for only a part of the consumption bundle (e.g., food, meat, etc.).

A disadvantage of these modern studies is that the conditions required to rationalize the functional forms applied and the appropriateness of the theoretical restrictions in the aggregate data are very strong or have not been completely rationalized. An exception is for the partial demand systems, developed in recent pieces by LaFrance and Hanemann (1987 and 1983). The interpretation of these empirical results is as a type of approximation to the true aggregate or market demand system. Unfortunately, information on the nature of this loosely argued local approximation is generally not available.

Partial Specifications

Certain empirical analyses of consumer demand do not fit within the framework just outlined. These are the empirical demand analyses from which most claims of structural change have emerged. In fact, they are the demand results largely responsible for stimulating the chicken little psychology. Generally, they are for ad hoc specifications derived from extensive experimentation in aggregate time series or market data. No conclusions on structural change can be drawn from results of applying these specifications. In addition to the problems related to the theory and hypotheses for structural change, these results are usually seriously flawed from a statistical viewpoint. They do not reflect, in the reliability statistics presented, the effects of pretests that have very likely occurred in the sample data (Fomby et al., 1984). In short, alternative hypotheses are not well defined and a very weak prior for the specification applied is implied. Fortunately, the papers in this session on price and income effects recognize these problems. This recognition is especially important if the reason for the empirical work is to

provide information on demand structure and the viability of the traditional theory of consumer demand.

The Four Papers

In general, the papers are of three types. Haidacher and Huang provide an evaluation of the consumption impacts of price and income change as estimated from an application of a full demand system. The papers by Thurman and Dahlgran concern specific hypotheses about changes in the price and income effects. The Wohlgenant piece can be seen as an investigation of a data-related problem in explaining changing demand parameters for beef and poultry.

Haidacher and Huang

It is unfortunate that a general piece like the one by Haidacher and Huang was not available at the time the major changes in meat consumption patterns began to emerge. The conclusion from their empirical analysis is that price and income effects, as estimated using elasticities from a full demand system framework, explain a major share (over 95 percent) of the variation in meat consumption levels that occurred during the period 1954 through 1983. Perhaps the most important subsidiary conclusion involves the contribution of cross price elasticities to explaining changes in the consumption of poultry relative to the red meats.

There are limitations in the method employed by Haidacher and Huang. The functional form applied must be argued as appropriate at an approximation to the true market demand structure; and, a number of arbitrary decisions were used (as would be the case in any other study) in preparing the data. However, their results leave only 5 percent of the consumption variance to be attributed to preference change, problems with the data, and socioeconomic and demographic change during the period.

Of course, the more subtle effects of these other factors accounting for change in structure should be estimated simultaneously with price and income responses. But, the empirical evidence provided, including only price and income effects, is most appealing. Careful applications of the demand systems methods can provide valuable information for explaining the changes in meat consumption patterns that have occurred during the past 20 years.

The limitations of the Haidacher and Huang analysis are largely related to the demand system used for generating the results and the data. This demand system is aggregate and approximate. To develop this demand system, Huang (1985) applied in the market data restrictions that we know not to be true on the basis of standard aggregation results for consumer demand systems. The functional form applied, if the aggregation conditions were forced, would severely restrict the cross price elasticities, income elasticities, and own price elasticities (LaFrance and Hanemann, 1983). Unfortunately, we do not know the market demand structure. The success of the empirical analysis by Huang (1985) together with similar applications (e.g., Capps and Havlicek, 1984; Safyurtlu et al., 1986) indicates, however, that the approximations being used must be reasonable and that cross price effects are important in understanding meat consumption. Obviously, much work is required to better rationalize these approximations.

Along with this observation, there are one or two peccadillos that can be offered in regard to the data and the way that the demand system of Huang (1985) was applied. If my interpretation of the procedures is correct, one set of initial or reference budget shares was used for specializing the restrictions. Obviously, the different price and income values in the time series imply different budget shares. Perhaps if budget shares had been updated annually, recognizing

explicitly that the restrictions and system are approximations, the explanation of the changes in consumption patterns for meats could have been improved. Second, more care might have been taken in identifying points in time series at which important revisions were made in the data. Perhaps changes in the data series are responsible for the years at which the demand system did not provide a good explanation for the observed changes in consumption. From the piece in the previous session by Nelson and Duewer, there are reasons to reexamine the aggregate consumption data. Similar observations apply for the prices or price indices used. Generally, however, the exercise by Haidacher and Huang goes a long way in dispelling the popular belief that the standard consumer theory is not capable of explaining the meat consumption patterns during the past 10 to 20 years.

Thurman

Thurman's conclusions derive largely from the application of a quad-log expenditure system for three meat commodities: pork, poultry, and beef. These results have useful implications for the price and income effects and possible changes over time. Another result is developed as a preliminary to the demand system estimates. This result is a summary of earlier work by Chalfant and Alston (1986) and Thurman (1986) and indicates that on the basis of choice consistency results from the theory of consumer demand, there is no evidence of changed preferences in the aggregate data. This conclusion is not specific to a particular form for the demand system and at first seems quite general. It is not, but for reasons other than those mentioned. Thurman correctly observes that the lack of control for real expenditure weakens the test. In addition, the analysis depends upon the use of historical per capita consumption data to reflect decisions of a representative consumer. But, to treat the market data, expressed on a per capita basis, as if they were for a representative consumer requires incorporation of the already-discussed strong assumptions on responses to price and income change.

The more specific empirical results relate to changes in own and cross price effects and income elasticities. Attention is directed to the cross price effect between poultry and pork, the rising income elasticities for all meats, and the erratic own price effects for beef and poultry. Explanations are offered (away-from-home eating, changing marketing channels, and health) but are not directly incorporated into the model specification. The results are interpreted as suggesting temporal changes in price and income effects. However, the restricted system, including only the meat commodities, and the importance of the implicit untested assumptions in the quad-log model prohibit a conclusive assessment of structural change in the demand for meat. Thurman could have been more self-critical, acknowledging more completely the restrictions imposed by the model specification and the implications of releasing those restrictions through the use of the trend and other variables for characterizing changes in parameter values over time.

The observations on away-from-home food consumption suggest a potentially valuable area for extending the work on demand systems for meat. There is a trend to away-from-home food consumption. Moreover, since in buying away-from-home foods the consumer is purchasing more services, it seems logical that the own price effects for meat should be reduced. The issue is with the data. Do the data on disappearance of beef mean the same thing when a larger share of the beef is being consumed in fast food outlets as hamburger? There is no particular reason to quibble with the conjectures offered by Thurman. It is important to note, though, that they are not supported directly by demand system estimates.

Dahlgran

The piece by Dahlgran is one for which our remarks in the preceding and following sections are most at variance. Dahlgran has argued that general models of structural change must be introduced. Variational parameters hypotheses have been introduced in a Rotterdam model and applied for five commodity groups. Results are interpreted as indicating that the structure of demand for meat changed during the 1970s but since the 1980s has returned to something more consistent with the structure of the 1960s. In part, this result is explained by the exponential hypothesis on the variations in parameter values. A related conclusion is that own price responses are more inelastic during the 1980s than in the 1960s. The directions of the own price elasticity changes are consistent with those obtained by Thurman.

It is again emphasized that the results on the changing structure of demand are specific to the model. The Rotterdam model imposes strong conditions on consumption responses to cross price, own price, and income changes. The extent to which the restrictions on own and cross price effects have contributed the results on structural change is not clear. These restrictions of the Rotterdam model are relaxed (and their interpretation made difficult) by introducing an ad hoc hypothesis of structural change. Aside from flexibility due to additional parameters, no reason is advanced for the particular specification used to explain changed structure. This is unfortunate since the conclusions on structural change are highly specific to the demand system and the hypothesized form for parameter variation.

The empirical results indicate changes in the structure of demand but have limited implications theoretically or for policy. What has been shown is that a demand system implying highly restrictive behavior of consumers fit over a period 1950 through 1985 can be improved statistically by incorporating an hypothesis of parameter change. It is important not to overgeneralize from these results. There is a tendency by Dahlgran (and Thurman) to claim more for the empirical results than is justified, abstracting from statistical problems. Again, the empirical results are a specific demand system. There is good reason to believe that these systems imposed choice restrictions inconsistent, even for the individual consumer, with commodity groups aggregated to the level used in the analyses. With these strong restrictions, it is not surprising that the parameters want to move as relative values of prices, income, and consumption change during the estimation period. They are permitted to change but at the expense of significantly altering the underlying demand system. Why use the systems in the first place? There is no shortcut to advancing the theory or better reflecting the nature of the data if structural change is to be explained.

Wohlgenant

The piece by Wohlgenant has useful implications for interpreting demand systems estimated with aggregated data when the composition within the commodity aggregates and within the group relative prices has changed. Specifically, it is argued from a fed/nonfed beef analysis that the increase in hamburger as a share of beef has resulted in different cross price effects among poultry, beef, and pork. The empirical results are intuitively appealing, indicating that low-quality beef, including hamburger, competes against lower priced other meats, specifically poultry. The implication is that knowledge of the composition of commodity aggregates is essential to understanding the consumption patterns for red meat.

The fact that these results were obtained in a Rotterdam model, which again imposes strong restrictions on cross price effects, detracts from their generality. Alternatively, the consistency of the trends in the elasticities with the results of Thurman and Dahlgran provides motivation for additional studies, maintaining the restrictions on the demand systems and providing more complete hypotheses for structural change. The immediate implication of the Wohlgenant

paper for structural change is that differences in estimated demand parameters to date attributed to structural change may be, in fact, a result in shifts within the composite commodities.

The research implications of the study are for improved data bases and more careful use of existing data. The aggregate beef as a composite commodity has important limitations for developing demand parameters used in policy analysis. This is due to the specialized markets for hamburger or low-quality beef. If empirically estimated demand systems are to be used for effective agricultural policy analysis in the red meat industry, more disaggregated studies appear necessary.

Wohlgenant recognizes explicitly the fact that the Rotterdam model forces strong assumptions on the cross price elasticities and that these restrictions could be responsible for the changed cross price elasticities observed over time. As a partial approach to verifying this effect, a different model was applied based on a Fourier flexible form. This model is less restrictive than the Rotterdam model and generated point estimates with patterns similar to those for the Rotterdam model. An alternative way to have derived the result would have been to investigate specifically the restrictions from the Rotterdam and Fourier models relative to the cross price elasticities. This is a tedious analytical task. The Fourier results do support the observation that a change in the cross price elasticities may have occurred and that this change may be related to the composition of the beef aggregate.

General Observations

The results presented in the papers in this section are encouraging relative to the capacity of modern demand theory for explaining changed consumption patterns for meat. They suggest three general observations, and go a long way toward debunking the chicken little psychology about the consumer demand theory and the demand for meat. The general observations are:

- Conventional demand systems results provide explanations for most of the change in meat consumption patterns that has occurred during the past 20 to 30 years.

- There appear to be temporally related changes in values of the cross price elasticities, particularly relative to poultry. These changes may be due to problems with homogeneity in the commodity and price aggregates, e.g., hamburger and away-from-home eating patterns. If the results on cross price elasticities are correct, there are strong implications for the fed and nonfed beef and poultry industries.

- Important aggregation problems remain for analyses of market demand. There are two alternatives: the use of highly restricted demand systems or application of approximate systems for which the theory is not well developed. Both have major limitations for supporting conclusions about structural change.

Extensions of the applied work could take a number of directions. Three possibilities are suggested. These suggestions are motivated by the emphasis on meat (a relatively small component of total consumption), the competing hypotheses implicit in the demand systems specifications, and the difficulties with market versus individual demand functions and approximations.

Recent pieces by LaFrance and Hanemann (1983 and 1987) are useful for assessing partial demand systems. Their results show that properties of full demand systems carry over to incomplete demand systems. These incomplete demand systems are attractive for analyzing food commodities, since obtaining prices and consumption levels for some of the nonfood commodities are themselves difficult research problems. To deal adequately with these

problems in the nonfood area distracts from the emphasis on meat demand. There are, of course, complications with the incomplete or partial demand systems approach. However, these recent results are useful for rationalizing and interpreting the more specialized expressions (usually involving incomplete systems) used in studies of the structure of meat demand.

The competing hypotheses question is one for which the statistical technology has developed rapidly in recent years. There now are an array of non-nested hypotheses tests that can be applied in demand systems estimation (Fomby et al., 1984). These tests appear useful for evaluating empirically the restrictions implicit in the alternative demand systems. We presently have conclusive results from specific applications but inconclusive results from empirical comparisons of alternative demand systems. While these non-nested hypotheses tests are not powerful, they do provide a way for discriminating among competing hypotheses. Applied consumer demand analysts, with the approximate demand systems (e.g., Huang, 1985), integrable demand systems (e.g., Rotterdam and linear expenditure), and hypotheses for structural change as competing explanations for changed consumption patterns, could advantageously use these statistical tests. It is emphasized, however, that these are tests only for empirical correspondences. Additional analysis is required to evaluate the implicit restrictions for the demand systems and their structural change implications.

The third suggestion involves approximate demand systems. The fact that the results of Brandow and the related studies on demand systems have held up for approximately 20 years suggests there is value in exploring more carefully approximations for estimating aggregate demand systems. This observation is supported by the recent work of Capps and Havlicek (1984), Huang (1985), and Safyrutlu et al. (1986), which shows that the methods pioneered by Schultz and Brandow (when adapted to incorporate modern estimation methods) continue to produce plausible parameter estimates and systems with good explanatory power. Perhaps ideas of local approximations and limited aggregation theorems should be studied in more detail.

Conclusions

The conclusions from evaluation of the papers have been anticipated in the previous section. The major conclusion is that existing demand systems approaches can explain most of the changes in meat consumption that have occurred during the past 30 years. There are trends in key own and cross price elasticities and in the income elasticities that emerge from the three specialized applications (Dahlgran, Thurman, and Wohlgenant). However, these trends may be due more to changes in composition of the price and commodity aggregates and the population generating the market data than to preference changes. Trends in technology and, relatedly, relative prices of the subcomponents of the meat commodity aggregates have important implications for the observed changes in the demand systems parameters and can lead to informative alternative hypotheses for changes in structure. In addition, standard demand systems results can be enhanced by inclusions of simple variables reflecting, for example, the different location patterns and age/sex distributions of the population.

Agricultural economists knowledgeable in demand systems estimation knew much more about the changed meat consumption parameters than the chicken little syndrome would suggest. The sky is not falling on the red meat industry! The existing theory and straightforward extensions continue to hold the best potential for understanding the changes in meat consumption patterns. In addition, analyses conducted with the benefit of this framework provide the best opportunity for developing extensions to permit more complete assessments of aggregate or market-level consumer demand.

References

Barten, A.P. 1967. "Evidence on the Slutsky Conditions for Demand Equations." Review of Economics and Statistics 49:77-84.

Blanciforti, L. and R.D. Green. 1983. "An Almost Ideal Demand System Incorporating Habits: An Analysis of Expenditures on Food and Aggregate Commodity Groups." Review of Economics and Statistics 65:511-515.

Brandow, G.E. 1961. Interrelationships Among Demands for Farm Products and Implications for Control of Market Supply. University Park: Pennsylvania Agricultural Experiment Station Bulletin 68.

Brown, Mark, Richard Green, and S.R. Johnson. 1985. "Preferences and Optimization: Tests within the Almost Ideal Demand System," Working Paper, University of Missouri-Columbia.

Buse, Reuben C. 1986. "Overview: What is America Eating and What is Happening to the Consumption of Animal Products?" Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.

Byron, R.P. 1970. "The Restricted Aitken Estimation of Sets of Demand Relations." Econometrica 38:816-830.

Capps, O. and J. Havlicek. 1984. "National and Regional Household Demand for Meat, Poultry and Seafood: A Complete Systems Approach." Canadian Journal of Agricultural Economics 32:93-108.

Chalfant, J.A., and J.M. Alston. 1986. "Accounting for Changes in Tastes." University of California, Department of Agricultural and Resource Economics, CUDARE Working Paper 402, Berkeley.

Chavas, Jean-Paul. 1983. "Structural Change in the Demand for Meat." American Journal of Agricultural Economics 65:148-53.

_____. 1986. "The Structure of the Demand for Meat: Why is it Important?" Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.

Choi, E.K., H. Jensen, and S.R. Johnson. 1987. "Advertising, Consumption Externalities, and the Demand for Dairy Products." Iowa State University, Center for Agricultural and Rural Development Working Paper (forthcoming), Ames.

Dahlgran, Roger A. 1986. "Is U.S. Meat Demand in Equilibrium?" Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.

Deaton, A. and J. Muellbauer. 1980. Economics and Consumer Behavior. New York: Cambridge University Press.

Diewart, W.E. 1980. "Symmetry Conditions for Market Demand Functions." Review of Economic Studies 47:595-601.

Eisenberg, B. 1961. "Aggregation of Utility Functions." Management Science 7:337-350.

Fomby, T.B., R.C. Hill, and S.R. Johnson. 1984. Advanced Econometric Methods. New York: Springer-Verlag.

Frisch, R.A. 1959. "A Complete Scheme for Computing All Direct and Cross Demand Elasticities in a Model with Many Sectors." Econometrica 27:177-96.

Gallant, A.R. 1981. "On the Bias in Flexible Functional Forms and an Essentially Unbiased Form: The Fourier Flexible Form." Journal of Econometrics 15:211-245.

George, P.S. and G.A. King. 1971. Consumer Demand for Food Commodities in the United States with Projections for 1980. Giannini Foundation Monograph 26. Davis: University of California.

Gorman, W.M. 1976. "Tricks with Utility Functions." In Essays in Economic Analysis, M. Artis and R. Nobay (eds.), Cambridge: Cambridge University Press.

Green, R., Z. Hassan, and S.R. Johnson. 1979. "Price Elasticity Estimates from Family Expenditure Data: An Application of the Extended Linear Expenditure System." Canadian Journal of Agricultural Economics 27:41-52.

Haidacher, Richard C. and K.S. Huang. 1986. "An Assessment of Price and Income Effects on Changes in Meat Consumption." Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.

Haidacher, Richard C., David Smallwood, and James Blaylock. 1986. "A Review of the Research Literature on Meat Demand." Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.

Hassan, Z.A. and S.R. Johnson. 1976. Consumer Demand for Major Foods in Canada, Economics Branch No. 76/2. Agriculture Canada.

Howe, H. 1977. "Cross-Section Application of Linear Expenditure Systems: Responses to Sociodemographic Effects." American Journal of Agricultural Economics 59:141-48.

Huang, K.S. 1985. "U.S. Demand for Food: A Complete System of Price and Income Effects." USDA/ERS Technical Bulletin No. 1714.

Huang, K.S. and R.C. Haidacher. 1983. "Estimation of a Composite Food Demand System for the United States." Journal of Business and Economics Statistics 1:285-291.

Johnson, S.R., Z.A. Hassan, and R.D. Green. 1984. Demand Systems Estimation: Methods and Applications. Ames: Iowa State University Press.

LaFrance, J.T. and W.M. Hanemann. 1983. "The Structure of Certain ad hoc Models of Market

Demand Functions." Montana State University, Agricultural Economics and Economics Department Staff Paper No. 83-10, Bozeman.

_____. 1987. "The Dual Structure of Incomplete Demand Systems." Montana State University, Agricultural Economics and Economics Department Staff Paper No. 87-1, Bozeman.

Lluch, C., A.A. Powell, and R.A. Williams. 1977. Patterns in Household Demand and Saving. New York: Oxford University Press.

Muellbauer, J. 1976. "Community Preferences and the Representative Consumer." Econometrica 44:979-999.

Nelson, Kenneth E. and Lawrence A. Duewer. 1986. "ERS Measures of Red Meat Consumption." Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.

Pope, R., R. Green, and J. Eales. 1980. "Testing for Homogeneity and Habit Formation in a Flexible Demand Specification of U.S. Meat Consumption." American Journal of Agricultural Economics 62:778-784.

Ray, R. 1980. "Analysis of Time Series of Household Expenditure Surveys for India." Review of Economics and Statistics 62:595-602.

Safyurtlu, A.N., S.R. Johnson, and Z.A. Hassan. 1986. "Recent Evidence on Market Demand Systems for Food in Canada." Canadian Journal of Agricultural Economics 34:475-493.

Schrimper, Ron. 1986. "Cross-Sectional Data in Demand Analysis." Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.

Schultz, H. 1938. The Theory and Measurement of Demand. Chicago: Chicago University Press.

Sonnenchein, H. 1973a. "Do Walras' Identity and Continuity Characterize the Class of Community Excess Demand Functions?" Journal of Economic Theory 6:345-354.

_____. 1973b. "The Utility Hypothesis and Market Demand Theory." Western Economic Journal 64:404-410.

Taylor, T.G., J.S. Shonkwiler, and H. Theil. 1986. "A Monte Carlo and Bootstrap Testing of Demand Homogeneity." Economics Letters 20:55-57.

Teklu, Tesfaye and S.R. Johnson. 1987. "Demand Systems from Cross Section Data: An Experiment for Indonesia." Iowa State University, Center for Agricultural and Rural Development Staff Report 87-SR37, Ames.

Theil, H., J.S. Shonkwiler, and T.G. Taylor. 1985. "A Monte Carlo Test of Slutsky Symmetry." Economics Letters 19:331-332.

Thurman, Walter N. 1986. "Have Price and Income Elasticities Changed? Their Connection with

Changes in Marketing Channels." Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.

Wohlgenant, Michael K. 1986. "Effect of the Changing Composition of Beef Consumption on the Elasticities for Beef and Poultry." Paper presented at "The Demand for Red Meat: What Do We Know? What Does It Mean?" symposium sponsored by Southern Regional Research Committee (S-165) and Board on Agriculture of the National Research Council, Charleston, South Carolina.