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Abstract

Little research has quantified the impact of demographics and health information on meat demand, and no previous study has examined multiple demographic and health information variables simultaneously in a demand system, which this research does. Results of this study suggest that changes in demographic characteristics and increasing health awareness have influenced the changes in meat demand.

Keywords: demographics, health, meat demand

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During the past few decades, Americans have made noticeable adjustments in their diets in terms of what and where they eat; consequently, the demand for meat has experienced dramatic changes. While the quantity consumed of red meats has consistently declined in recent decades, that of poultry and seafood have grown substantially. What factors caused these trends? Previously, these shifts in shares in the meat complex have been principally attributed to income and relative price changes. However, other relevant and complex forces may also be driving meat consumption patterns. It appears possible that changing demographics, changing lifestyles, increasing health and nutrition concerns, and increasing demand for convenient products are important factors impacting changes in meat demand.

Despite the considerable changes occurring in demographics and lifestyles, little research has documented the impact of changes in these factors on the demand for beef, pork, and poultry. The objective of this study is to determine the impacts of changing consumer demographics and health information on the demand for beef, pork, and poultry. Specifically, this study will directly incorporate selected demographic and health information variables in a meat demand system in addition to the standard demand factors of prices and income. In doing so, this study will attempt to quantify important non-price determinants of meat demand, and hence, provide a better understanding of the non-price factors affecting consumer demand for meat. Quantifying the effects of price and various non-price factors on the demand for meat is important for firms considering research, product development, promotions, and strategy development for reacting to change and for improving market share.

A plethora of literature has examined various aspects of the demand for meat (Alston and Chalfant 1991; Brester and Schroeder; Brester and Wohlgenant 1991, 1993; Capps; Capps and Schmitz; Chalfant and Alston; Choi and Sosin; Eales et al.; Eales and Unnevehr 1988, 1993; Kinnucan et al.; McGuirk et al.; Moschini and Meilke; Thurman). However, little research has quantified the impact of demographics and health information on meat demand, and no previous study has examined multiple demographic and health information variables simultaneously in a demand system, which this research will do.

LaFrance examined the effects of the mean, variance, and skewness of the U.S. population's age distribution and the proportion of the population belonging to various races on the consumption of 21 food items and 17 nutrients, including beef, pork, and poultry. He found the mean and variance of the age distribution and the percentage of the population that is black and the percentage of the population that is neither white nor black to be significant demographic variables in beef consumption, the variance of the age distribution and the percentage of the population that is black to be significant in pork consumption, and the percentage of the population that is neither white nor black to be significant in poultry consumption. He did not include a variable to estimate the effect of health information.

Cortez and Senauer used a nonparametric method to examine the demand for nineteen major food categories including beef, pork, and poultry, among several U.S. demographic groups. They concluded differences exist in food consumption patterns and in taste changes among demographic groups. In particular, they found a preference shift away from beef to be far stronger for a group consisting of higher-income households with older heads and more-educated spouses than for a group consisting of lower-income households with younger heads and less-educated spouses. They also concluded that tastes shifted toward pork and away from poultry for the higher-income, older head, more-educated spouse group whereas the reverse occurred for the lower-income, younger head, less-educated spouse group.

Capps, Moen, and Branson examined demographic characteristics of consumers associated with the willingness to try lean meat products from a retail store. They estimated a probit model using survey data gathered from consumers at retail food stores in Houston. They concluded that age, education level, household size, and Texas residency were significant demographic factors affecting consumers' decisions to try lean meat products.

Capps and Schmitz suggested that health and nutrition factors should be considered in food demand analysis, and they provided a theoretical framework for considering such factors. They also discussed some of the challenges associated with accounting for health information in demand analysis. Kinnucan, Xiao, Hsia, and Jackson considered the effects of health information and advertising on U.S. meat demand by incorporating variables for these factors in the Rotterdam model as separate shift variables. They found health information effects were robust with poultry consumption benefitting from dispersion of health information, beef consumption losing ground, and pork consumption unaffected. They also found that health information elasticities exceeded price elasticities in absolute terms implying that small percentage changes in health information create greater changes in meat consumption than equivalently small percentage changes in relative prices.

Incorporating Demographic and Health Variables into the Rotterdam Model

The Rotterdam model, which has been used several times in previous research (Brester and Schroeder; Capps and Schmitz; Kinnucan, Xiao, Hsia, and Jackson) to model meat demand, was selected as the specification for the model in this study. The Rotterdam model was chosen because it is consistent with demand theory (Theil); it is as flexible as other approximating forms (Mountain); and previous studies have shown the model useful in capturing non-price effects (Brester and Schroeder; Kinnucan, Xiao, Hsia, and Jackson). The demand system consists of equations for beef, pork, and poultry, implying a maintained hypothesis of weak separability of the meat group. Chicken and turkey demand are aggregated to form the demand for poultry which is then modeled in the system. Eales, Hyde, and Schrader have shown that either using this approach or just using chicken data is appropriate for modeling poultry demand. Total meat expenditure is used in the model instead of income. Demographic and health information variables are incorporated into the model as shifters of demand in order to evaluate the effects of changes in these factors on the demand for beef, pork, and poultry.

Several approaches exist for incorporating demographic and other non-price variables into demand analysis. Pollak and Wales previously used translating to incorporate demographic factors into demand functions. Demographic scaling, the Gorman procedure, the reverse Gorman procedure, and the modified Prais-Houthakker procedure are also methods for including demographic and health variables in demand functions (Pollak and Wales). Another possible approach is to view these variables as shifters of demand or taste shifters that affect marginal utility. This has been a common approach for including advertising and health information variables in demand analysis (Kinnucan, Xiao, Hsia, and Jackson; Capps and Schmitz; Piggott, Chalfant, Alston, and Griffith). This approach views these variables as inputs in the household production function. Presumably, demographic characteristics and health information change the consumption of meat. Therefore, specifying demographic characteristics and health information as separate taste shift variables in the Rotterdam model is appropriate. The basic absolute-price version of the Rotterdam model used in this analysis is as follows:

(1)
$$
\begin{aligned}
w_i d \ln q_i &= \beta_i \, d \ln Q + \sum_{j=1}^{n} \gamma_{ij} \ \ln \ p_j + \delta_i d \ln A + \varepsilon_i d \ln V \\
&\quad + \theta_i d \ln H + \lambda_i d \ln H_{-1} + \mu_i d \ln B + \tau_i d \ln O \\
&\quad + \phi_i d \ln E + \psi_i d \ \ln F + u_i
\end{aligned}
$$

where i indexes the equation (i = 1, 2, 3 for beef, pork, and poultry, respectively) and d ln Q = $\sum_i w_i d \ln q_i$ is the Divisia volume index, w_i is the expenditure share of the ith meat, d is the first difference operator, q_i is per capita consumption of meat item i, p_j is the retail price of meat item j, A is the mean age of the population, V is the variance of the population's age, H is a health information index, H_{-1} is the health information index lagged one period, B is the percentage of the population which is black, O is the percentage of the population which is neither white nor black, E is the mean years of education of the population, F is the percentage of the female population who work, u_i is a random error term, and β_i, γ_{ij}, δ_i, ε_i, θ_i, λ_i, μ_i, τ_i, φ_i, and ψ_i are parameters to be estimated.

The testable restrictions in equation (2) impose symmetry and homogeneity across the demand system while the nontestable restrictions in equation (3) impose adding up restrictions. The adding up restrictions are necessary in order to recover the parameter estimates of the equation deleted from the empirical estimation:

(2)
$$
\begin{aligned}
&Symmetry: \ \gamma_{ij} = \gamma_{ji} \quad \forall i, j; \\
&Homogeneity: \ \sum_{i=1}^{n} \gamma_{ij} = 0 \quad \forall i
\end{aligned}
$$

(3) $$Adding\ up:\ \sum_{i=1}^{n} \beta_i = 1;$$

$$\sum_{i=1}^{n} \gamma_{ij} = 0, \qquad j = 1, 2, ..., J;$$

$$\sum_{i=1}^{n} \Omega_i = 0 \qquad where\ \Omega = \delta, \varepsilon, \theta, \lambda, \mu, \tau, \phi, \psi.$$

Elasticities were calculated using the following equations:

(4) $$Expenditure\ \Lambda\ Demographic\ Elasticities:\ \varepsilon_{ik} = \chi_i \sqrt{w_i}$$

$$where\ \chi = \beta, \delta, \varepsilon, \mu, \tau, \phi, \psi;$$

$$Hicksian\ Compensated\ Price\ Elasticities:\ \varepsilon^*_{ij} = \gamma_{ij} \sqrt{w_i}$$

$$Health\ Information\ Elasticities:\ \varepsilon_{iH} = (\theta_i + \lambda_i) \sqrt{w_i}$$

where $\bar{w}_i$ is the mean of the expenditure share weight of the *i*th meat, and all other variables are as previously defined.

The demographic characteristics of the U.S. population have changed throughout the century. Ethnic/racial diversity has increased, decreasing the percentage of the population that is white. The age distribution and its characteristics have also changed during the century. Mortality and fertility rates have declined, which has led to longer life spans and an overall aging population. More women are working, and the population is more educated. Additionally, health and nutrition information has become more abundant. Consequently, Americans have become more health conscious and have modified their diets. Presumably, all these changes have affected meat consumption patterns, and thus, have played a role in the dramatic changes experienced by the meat complex during recent decades.

Data and Estimation Procedure

The data set consists of annual time series observations for the period 1960-1998. Beef, pork, and poultry (chicken and turkey) per capita consumption data were obtained from the Livestock Marketing Information Center (LMIC). Price data for these commodities were collected from the U.S. Department of Agriculture's *Livestock, Dairy, and Poultry Situation and Outlook Report*. Prices were deflated using the Consumer Price Index (CPI) for nondurable goods (1998=100) which was obtained from the U.S. Department of Labor, Bureau of Labor Statistics (BLS). Demographic data for the age distribution of the U.S. population, the education level of the U.S. population, the proportion of women who work, and for the proportions of the U.S. population that are black and neither white nor black were taken from the *Statistical Abstract of the United States* published by the U.S. Department of Commerce. The mean and variance of the estimated age distribution were based on various age interval categories of the resident population. Trend line regressions were used to estimate six missing data points for these variables. The mean education level of the population was based on the years of school completed by people 25 years old and over. The proportion of women working was determined by the female labor force as a percentage of the female population. The ethnic variables were constructed using resident black population, resident population that was neither white nor black, and total resident population.

The weighted Brown and Schrader health information index created and used by Kinnucan, Xiao, Hsia, and Jackson was obtained from Kinnucan et al. The authors constructed the index using Brown and Schrader's cholesterol information index as basic data and then weighted it by a factor representing the relative proportion of all articles supporting a link between cholesterol and heart disease (negative information). For a more detailed explanation of the index construction, see Kinnucan, Xiao, Hsia, and Jackson, and Brown and Schrader. The weighted Brown and Schrader index was quarterly running from 1960.1 to 1993.4 and cumulative. This index series was updated through 1998.4 for this study. Since the index was cumulative, an annual index was created using just the fourth quarter index value as the annual value. This makes the index consistent with the cumulative annual consumption and price data used. Additionally, if consumers' attitudes change as information accumulates and becomes available, then a cumulative annual index is appropriate. Since the index was zero in some years, it was necessary to modify the series in order to accommodate the logarithmic specification of the Rotterdam model. Following Kinnucan, Xiao, Hsia, and Jackson, this issue was addressed by adding a small positive number (0.0001) to each observation, zero and non-zero values alike.

The model was estimated in SHAZAM 8.0 using seemingly unrelated regressions (SUR). For estimation purposes, the typical procedure of deleting one equation from the system, estimating the remaining system, and recovering the parameters of the deleted equation by using the linear restrictions was followed in this study. The equation describing poultry consumption was the equation deleted from the estimation. The model was estimated without a constant term allowing the demographic and health variables to capture trends in the data. Symmetry and homogeneity were imposed in the estimation while the adding up restrictions were imposed when the parameter estimates of the deleted equation were recovered.

Empirical Results

Table 1 presents the definitions of the variables included in the analysis. Tables 2 and 3 present the regression results for the unrestricted and restricted models, respectively. Eigen values indicate the matrix of price effects is negative semidefinite suggesting that curvature restrictions are met in the unrestricted model. Wald tests for the restrictions of symmetry and homogeneity indicate that homogeneity does not hold with or without symmetry imposed. Likewise, symmetry does not hold regardless of homogeneity. Using a Hausman test, simultaneity between the quantity and price variables was rejected at the 0.05 level.

Regression results for the model with symmetry and homogeneity imposed (Table 2) indicate that own price effects are significantly different from zero with signs consistent with a priori expectations. Nearly all cross-price effects are also significantly different from zero. Cross-price effects indicate that the three meats are substitute goods for one another. Expenditure parameters are significantly different from zero in the beef and pork equations and positive, indicating the meat commodities are normal goods. Based on an asymptotic t-test, the individual demographic and health parameters are not significantly different from zero in any of the meat equations. Lack of statistical significance in the demographic parameters is consistent with work by LaFrance which also found the population's age and the non-white, non-black percentage of the population insignificant in the pork equation and the population's age, variance of age, and the black percentage of the population insignificant in the poultry equation.

To test the joint significance of the demographic and health variables in the demand system, we preformed a likelihood ratio test. The null hypothesis that selected demographic and health parameters are jointly equal to zero was rejected at the 0.05 level (see Table 4). This result suggests that these variables may have affected consumer demand for beef, pork, and poultry. Regression results (Table 2) also indicate that the signs on the demographic parameters differ from those reported by LaFrance for the population's age and age variance in the pork and poultry equations, for the black percentage of the population in the poultry equation, and for the non-white, non-black percentage of the population in the beef, pork, and poultry equations. The differences in results are due to the estimation of different models and study period, which covered the period from 1919 to 1995.

Table 5 presents estimated compensated price, income, demographic, and health elasticities. Elasticities are evaluated at the sample mean budget shares. The price elasticities are fairly comparable in most cases to those reported by Kinnucan, Xiao, Hsia, and Jackson, Brester and Schroeder, Brester and Wohlgenant 1991, and Eales and Unnevehr 1988. The health information elasticities are smaller than those reported by Kinnucan, Xiao, Hsia, and Jackson and have inconsistent signs for beef and poultry. The age elasticities suggest that while pork and poultry appear to suffer from the increase in the expected life span of the population, beef principally benefits in the form of greater consumption. The age elasticities indicate that a 1% increase in the mean age of the population increases beef consumption by 0.25%, decreases pork consumption by 0.15%, and decreases poultry consumption by 0.57%. The age variance elasticities indicate that a 1% increase in the variance of the age of the population increases beef consumption by 0.17%, decreases pork consumption by 0.24%, and decreases poultry consumption by 0.18%.

Elasticity results for the ethnic variables indicate that increased diversity in the population shifts consumption away from pork in the direction of beef and primarily more towards poultry. Results indicate that 1% increases in the black and the other ethnic (non-white and non-black) percentages of the population increase beef consumption by 0.10% and 0.02%, respectively, decrease pork consumption by 0.34% and 0.03%, respectively, and increase and decrease poultry consumption by 0.23% and 0.02%, respectively. Changes in the population which increases its diversity are carried through into meat consumption reflecting the differences in tastes and preferences of various ethnic groups.

The percent of women in the labor force and the education level of the population appear to have the largest economic impact on meat consumption according to results. As a greater number of women have entered the labor force, pork and poultry have benefitted while the beef industry has suffered. Results suggest that a 1% increase in the percentage of females in the labor force decreases beef consumption by 0.43%, while increasing pork and poultry consumption by 0.24% and 1.02%, respectively. Similarly, McGuirk, Driscoll, Alwang, and Huang found that increases in the number of married women in the work force lowers beef demand and increases the demand for pork and chicken. Elasticity results of their work are very comparable to ours with beef at 0.39%, pork at 0.36%, and chicken more elastic at 1.4%. Results of this study reflect the increase in demand for more convenient and less time consuming meal products. Pork, but especially poultry, have been successful at creating various value added, convenient, and time-saving products; beef has not met consumer demand for convenience products in the same manner. With the increased number of women working, meal preparation time has declined, and easier, more efficiently prepared products have become more important. Poultry has targeted this market and has benefitted; beef has not. These results are consistent with work by Capps, Tedford, and Havlicek which found that employed household managers apportion larger budget shares to convenience foods than unemployed household managers.

The education elasticities suggest that poultry has benefitted from the increasing education level of the population at the expense of pork and beef. Elasticity results imply that a 1% increase in the mean years of education decreases beef and pork consumption by 0.07% and 0.63%, respectively, and increases poultry consumption by 1.27%. Education results appear to reflect the demand for convenience products and health considerations, which typically suggest that poultry is superior to red meat, i.e., beef and pork, for fat and cholesterol health considerations. Capps, Tedford, and Havlicek also found that households with college educated managers allocate a larger proportion of the food dollar to convenience foods than households with non-college educated managers.

Increased general education and increased education regarding the health differences of meats is also reflected in the population's consumption patterns. Consumers who attend college have been found to be more likely to try lean meat products than consumers who did not attend college (Capps, Moen, and Branson). Health concerns were considered in this study by incorporating a health index variable. Health elasticity results are not consistent with those found by Kinnucan, Xiao, Hsia, and Jackson, and the level of significance found is much lower in this study. These results are likely induced by the inclusion of other variables in our model which also trend upward over time such as the variables for education and females in the labor force. The significance of the education and female labor variables reflect and capture the importance of the increases in health concerns as well. These demographic variables capture the changes in preferences occurring due to the increasing education level of Americans, the increasing number of women working, and the increasing health consciousness of the public. Changes in these preferences are important determinants of the demand for meat and are reflected in the changes in the meat complex, most notably on the demand for poultry.

Conclusions and Implications

The American diet has changed considerably over the past few decades and so has the demand for meat. Several factors have potentially motivated these changes including relative prices, income, convenience, advertising, education, health awareness, and changing demographics. This study used the Rotterdam model to quantify some of the factors driving meat demand in order to provide knowledge regarding their importance in demand changes. Of special interest in this study were the effects of changing demographics and health information. Results indicated that the joint marginal impacts of the mean population age, variance of the age, ethnic percentages of the population, mean education level of the population, the percent of women in the labor force, and health information were found to be significantly different from zero. The increasing mean age and variance of the age of the population have increased beef demand while decreasing pork and poultry demand. The increasing ethnic (non-white) diversity of the U.S. population has increased beef and poultry demand while decreasing the demand for pork. The increasing number of women working and the increasing education level of the population have had the largest non-price effects on meat demand with the greatest benefit belonging to poultry. More women in the labor force and a more educated and more health conscious public have increased poultry demand and decreased beef demand while having mixed effects on pork demand. These results suggest the importance of convenience and health in meal preparation. With greater levels of education and a more diverse labor force working a large number of hours, time and health are more important considerations in meat selection.

Results of this study suggest changes in various demographic characteristics and increasing health awareness have influenced the changes in the demand for meat. These results have practical significance for the meat industry. It is important for firms and organizations in the industry to know the factors driving and creating changes in meat consumption. Whether these factors are the economic elements of income and prices or demographic characteristics and tastes and preferences, knowledge about their effects on the demand for meat is valuable for product development, target marketing, and market share competition. Hence, the various meat sectors and government policymakers should keep these factors in mind when developing research, products, promotions, and marketing strategies.

Table 1. Definitions of Variables

Variable	Definition
Dependent	
QBEEF	Expenditure share weighted first difference of the natural logarithm of per capita consumption of beef.
QPORK	Expenditure share weighted first difference of the natural logarithm of per capita consumption of pork.
QPOULT	Expenditure share weighted first difference of the natural logarithm of per capita consumption of poultry.
Independent	
EXP	The difference between first differences of the natural logarithm of per capita personal consumption expenditures and a Divisia price index.
PBEEF	First differences of the natural logarithm of the price index of beef, (1998=100).
PPORK	First differences of the natural logarithm of the price index of pork, (1998=100).
PPOULT	First differences of the natural logarithm of the price index of poultry, (1998=100).
MAGE	First differences of the natural logarithm of the mean age of the population.
VAGE	First differences of the natural logarithm of the variance of the age of the population.
HLTH	First differences of the natural logarithm of the index of health information.
HLTH1	First differences of the natural logarithm of the one period lagged index of health information.
BLK	First differences of the natural logarithm of the percentage of the population which is black.
OETH	First differences of the natural logarithm of the percentage of the population which is neither white nor black.
FLB	First differences of the natural logarithm of the percentage of women who work.
EDU	First differences of the natural logarithm of the mean years of education of the population.

Table 2. Estimated Regression Coefficients of the Rotterdam Model with Symmetry and Homogeneity Imposed

	Independent Variables													
Dependent Variables	*EXP*	*PBEEF*	*PPORK*	*PPOULT*	*MAGE*	*VAGE*	*HLTH*	*HLTH1*	*BLK*	*OETH*	*FLB*	*EDU*	R^2	DW
QBEEF	0.690	-0.177	0.147	0.030	0.136	0.096	-0.125E-3	0.241E-3	0.0559	0.013	-0.237	-0.037	0.85	1.263
	(12.351)	(-7.918)	(8.882)	(2.646)	(1.143)	(0.844)	(-0.162)	(0.318)	(0.071)	(0.439)	(-1.186)	(-0.076)		
QPORK	0.293	0.147	-0.153	0.006	-0.041	-0.066	-0.102E-3	-0.732E-5	-0.095	-0.917E-2	0.066	-0.177	0.87	1.709
	(6.425)	(8.882)	(-10.543)	(0.779)	(-0.428)	(-0.718)	(-0.164)	(-0.012)	(-0.148)	(-0.381)	(0.406)	(-0.449)		
QPOULT	0.017	0.030	0.006	-0.036	-0.095	-0.030	0.227E-3	-0.234E-3	0.039	-0.383E-2	0.171	0.214	0.61	1.282
	(0.701)	(2.646)	(0.779)	(-3.330)	(-1.752)	(-0.584)	(0.663)	(-0.691)	(0.112)	(-0.290)	(1.925)	(0.985)		

Note: Numbers in parentheses are the t-values for the parameter estimates; R^2 is the raw moment R-squared statistic; DW is the Durbin-Watson test statistic. The log of the likelihood function for the regression is 288.42.

Table 3. Estimated Regression Coefficients for Conditional Demand Equations of the Rotterdam Model with Symmetry and Homogeneity Imposed

Dependent Variables	Independent Variables: *EXP*	*PBEEF*	*PPORK*	*PPOULT*	R^2	DW
QBEEF	0.655	-0.166	0.138	0.028	0.83	1.330
	(12.228)	(-7.415)	(8.813)	(2.038)		
QPORK	0.291	0.138	-0.155	0.017	0.85	1.712
	(6.794)	(8.813)	(-10.776)	(1.735)		
QPOULT	0.054	0.028	0.017	-0.045		
	(1.756)	(2.038)	(1.735)	(-3.205)	0.26	0.941

Note: Numbers in parentheses are the t-values for the parameter estimates; R^2 is the raw moment R-squared statistic; DW is the Durbin-Watson test statistic. The log of the likelihood function for the regression is 273.935.

Table 4. Likelihood Ratio Tests of Meat Demand Models

Null Hypothesis	LR Test Statistic	Critical $\chi^2_{.05,16}$	Test Result
Demographics & Health = 0	28.97	26.30	Reject $H_{0\ o}$

Note: Tests performed at the 5.0% significance level with 16 degrees of freedom.

Table 5. Estimated Compensated Price, Income, Demographic, and Health Elasticities

Elasticity of the Dependent Variables	With Respect to										
	EXP	*PBEEF*	*PPORK*	*PPOULT*	*MAGE*	*VAGE*	*HLTH*	*BLK*	*OETH*	*FLB*	*EDU*
QBEEF	1.253	-0.321	0.266	0.055	0.247	0.173	0.211E-3	0.102	0.024	-0.430	-0.067
QPORK	1.042	0.522	-0.544	0.022	-0.146	-0.235	-0.389E-3	-0.3398	-0.033	0.235	-0.631
QPOULT	0.103	0.1796	0.037	-0.216	-0.565	-0.175	-0.415E-4	0.234	-0.023	1.016	1.269

Note: Elasticities are calculated at the means of the expenditure share weights: 0.5508 (beef), 0.2807 (pork), and 0.1685 (poultry).

References

Alston, Julian M. and James A. Chalfant. "Can We Take the Con Out of Meat Demand Studies?" *West. J. Agr. Econ.* 16(July 1991):36-48.

Brester, Gary W. and Ted C. Schroeder. "The Impacts of Brand and Generic Advertising on Meat Demand." *Amer. J. Agr. Econ.* 77(November 1995):969-79.

Brester, Gary W. and Michael K. Wohlgenant. "Correcting for Measurement Error in Food Demand Estimation." *Rev. Econ. Stat.* (1993):352-56.

_____. "Estimating Interrelated Demands for Meats Using New Measures for Ground and Table Cut Beef." *Amer. J. Agr. Econ.* 73(November 1991):1182-94.

Brown, Deborah J. and Lee F. Schrader. "Cholesterol Information and Shell Egg Consumption." *Amer. J. Agr. Econ.* 72(August 1990):548-55.

Capps, Oral Jr. "Utilizing Scanner Data to Estimate Retail Demand Functions for Meat Products." *Amer. J. Agr. Econ.* 71(August 1989):750-60.

Capps, Oral Jr., Daniel S. Moen, and Robert E. Branson. "Consumer Characteristics Associated with the Selection of Lean Meat Products." *Agribusiness* 4(1988):549-57.

Capps, Oral Jr., and John D. Schmitz. "A Recognition of Health and Nutrition Factors in Food Demand Analysis." *West. J. Agr. Econ.* 16(July 1991):21-35.

Capps, Oral Jr, John R. Tedford, and Joseph Havlicek, Jr. "Household Demand for Convenience and Nonconvenience Foods." *Amer. J. Agr. Econ.* 67(November 1985):862-69.

Chalfant, James A. and Julian M. Alston. "Accounting for Changes in Tastes." *J. Polit. Econ.* 96(April 1988):391-410.

Choi, Seungmook and Kim Sosin. "Testing for Structural Change: The Demand for Meat." *Amer. J. Agr. Econ.* 72(February 1990):227-36.

Cortez, Rafael and Ben Senauer. "Taste Changes in the Demand for Food by Demographic Groups in the United States: A Nonparametric Empirical Analysis." *Amer. J. Agr. Econ.* 78(May 1996):280-89.

Eales, James, Jeffrey Hyde, and Lee F. Schrader. "A Note on Dealing with Poultry in Demand Analysis." *J. Agr. Res. Econ.* 23(December 1998):558-67.

Eales, James S. and Laurian J. Unnevehr. "Demand for Beef and Chicken Products: Separability and Structural Change." *Amer. J. Agr. Econ.* 70(August 1988):521-32.

_____. "Simultaneity and Structural Change in U.S. Meat Demand." *Amer. J. Agr. Econ.* 75(May 1993):259-268.

Kinnucan, Henry W., Hui Xiao, Chung-Jen Hsia, and John D. Jackson. "Effects of Health Information and Generic Advertising on U.S. Meat Demand." *Amer. J. Agr. Econ.* 79(February 1997):13-23.

LaFrance, Jeffrey T. "The Structure of U.S. Food Demand." *Working Paper No. 862*. California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics, University of California at Berkeley, (January 1999).

Livestock Marketing Information Center (LMIC), Lakewood, CO. Various reports.

McGuirk, Anya, Paul Driscoll, Jeffrey Alwang, and Huilin Huang. "System Misspecification Testing and Structural Change in Demand for Meats." *J. Agr. Res. Econ.* 20(July 1995):1-21.

Moschini, Giancarlo and Karl D. Meilke. "Modeling the Pattern of Structural Change in U.S. Meat Demand." *Amer. J. Agr. Econ.* 71(May 1989):253-61.

Mountain, D.C. "The Rotterdam Model: An Approximation in Variable Space." *Econometrica* 56(March 1988):477-84.

Piggott, Nicholas E., James A. Chalfant, Julian M. Alston, and Garry R. Griffith. "Demand Response to Advertising in the Australian Meat Industry." *Amer. J. Agr. Econ.* 78(May 1996):268-79.

Pollak, Robert A. and Terence J. Wales. "Demographic Variables in Demand Analysis." *Econometrica* 49(November 1981):1533-51.

Theil, H. "The Information Approach to Demand Analysis." *Econometrica* 33(January 1965):67-87.

Thurman, Walter N. "The Poultry Market: Demand Stability and Industry Structure." *Amer. J. Agr. Econ.* 69(February 1987):30-37.

United States Department of Agriculture. *Livestock, Dairy, and Poultry Situation and Outlook Report*. Various Issues.

United States Department of Commerce. *Statistical Abstract of the United States*. Various Issues.

United States Department of Labor, Bureau of Labor Statistics.