Health, Food Safety and Meat Demand

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Abstract

For nearly two decades, the U.S. beef industry has faced a long term structural change, which has resulted in consumers shifting from beef to chicken. This shift has occurred due to consumer concerns on cholesterol consumption. More recently, this industry has confronted new challenges on the safety of beef, due to the potential presence of biological contaminants. This study incorporates a measure on food safety with a measure on health information in a meat demand system. Beef safety information is found to have a modest impact on beef demand, but is dominated by health information.

Keywords: meat demand, health, food safety, LA/AIDS

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In the U.S. market, per capita consumption of beef has steadily declined and chicken consumption has increased during the past two decades. This shift in consumption patterns has been the subject of numerous studies with some concluding that this it is attributable to a structural change (Gao and Shonkwiler; Kinnucan et al). Specifically, consumers are shifting away from beef and to chicken because of concerns over the consumption of foods high in cholesterol, due to its association with heart disease. More recently, the beef industry has been besieged by new challenges which question the safety of beef, due to the potential for illnesses attributable to biological contaminants, including such pathogens as Escherichia coli (E. coli), salmonellosis, and bovine spongiform encepholopathies.

Incidences of illnesses and deaths have been linked to some of these biological contaminants and widely reported in the media. Notable among them was the Jack-in-the-Box case, where three children in the Pacific northwest died from eating E. coli contaminated hamburgers in 1993. In August of 1997, a record 25 million pounds of hamburger was recalled by Hudson Foods, due to E. coli contamination. Probably the most widely reported and sensational event was the Oprah Winfrey Show aired in April 1996, which discussed the possibility of people contracting BSE or mad cow disease from eating meat containing this pathogen.

This television program led a group of Texas feedlot operators to sue the talk show's host, producer, distributor, and a guest on the show. The plaintiffs claimed that they had suffered monetary losses due to inaccurate and disparaging comments made on the show, which they

alleged caused live cattle prices to drop. Interestingly, this case was the first legal challenge of the so-called "veggie libel laws," which have been enacted in 13 states. These laws prohibit inaccurate and disparaging remarks on perishable food products. Although cattle prices were observed to have dropped after the show's airing, it was not proven by the plaintiffs that it was solely attributable to the show (Hayenga). Therefore, the jury ruled in favor of the defendant. The issue not addressed in the trial, was the affect the show had on consumption behavior. Has media attention to food safety issues affected consumer behavior? During the show Ms. Winfrey spontaneously stated, "It has just stopped me cold from eating another burger?" Have consumers followed Oprah's example in responding to this and other "food scares" in the beef industry.

The objective of this paper is to determine whether information, disseminated through the media, on food safety issues related to beef has affected demand for beef and other meats. This issue is addressed through the use of linear approximate almost ideal demand system estimated for a beef, pork, and chicken. A variable measuring the media information on beef safety is coupled with a variable measuring consumer information on cholesterol in this analysis. While previous studies have introduced health information measures, which largely related to cholesterol information, in meat demand systems (Capps and Schmitz; Kinnucan et al), this is the first study to combine a specific, variable measure of health information with a measure on food safety. This study will provide beef producers and meat demand analysts with new information on the importance of this factor in influencing demand. Further, the relative impact of dietary health information and food safety information can be analyzed.

In the next section the empirical model used in this study is presented along with a discussion of related studies. This is followed by a description of the data and methods. The results are then presented with a discussion on their implications.

Empirical Model Incorporating Food Safety

The health hazards posed by consuming beef from BSE infected cattle is of greater concern in the United Kingdom, due to the widespread occurrence of this infection. Indeed, its implication for consumer health has been a matter for public discussion since the late 1980's in the United Kingdom. Some have hypothesized that the accelerated decline in beef consumption realized since 1989/90 has been due to growing consumer awareness of this issue. Burton and Young test this hypothesis by introducing an indicator measure of consumer awareness of BSE into a dynamic almost ideal demand system for meats (beef, lamb, pork, and poultry). Their indicator was simply the total number of British newspaper articles on BSE. Thus, their measure is similar in construct to Brown and Schrader's health (cholesterol) information indices. However, unlike Chang and Kinnucan, Burton and Young do not distinguish between articles that raise concerns over the potential hazard (negative articles) and those which attempt to dispel the risk this cattle infection poses to humans (positive). Their model was estimated for the period 1962 through 1993 using quarterly data. They find that BSE information resulted in a 6 percent decline in the share of consumer expenditures on beef during the early 1990's; over the long run, it is estimated to cause a 4.5 percent decline in the beef share. This finding emphasizes the need to incorporate food safety in demand analysis. Perhaps this factor should be incorporated with other demand shifters, like health information and generic advertising.

Kinnucan et al were the first to incorporate both health information and generic advertising in their analysis of U.S. meat demand. They measure health information using the index developed by Chang and Kinnucan, which accounts for negative and positive information on cholesterol--a "net publicity" measure. Using a Rotterdam model to estimate meat (beef, pork, poultry, fish) demand over the period 1975.II through 1993.IV, they find strong support for the inclusion of health information in demand systems. The health information elasticities were significant for poultry and beef, equaling 1.54 and -0.583 for these meats, respectively. Therefore, they conclude that there is support for the notion that health information has caused a structural change in demand. However, they did not find evidence indicating that generic advertising was important in explaining demand, supporting the findings of Brester and Schroeder.

Based on the findings by Burton and Young and Kinnucan et al, we introduce measures of food (beef) safety and health information in a linear approximate almost ideal demand system model (LA/AIDS). This model provides a first-order approximation to any demand system, satisfies the axioms of consumer choice exactly and, under certain conditions, aggregates perfectly over consumers (Deaton and Muellbauer). It is expressed in the form of budget shares, W_i, allocated to particular products, in this case alternative meats:

$$W_i = \alpha_0 + \sum_{j=1}^{n} \gamma_{ij} \ln P_j + \beta_i \ln(X/P^*), \qquad \textbf{(1)}$$

where P_j is the price of meat j, X is expenditures on meats, and P^* is a price index. The Stone's price index is used here. Beef, pork, and chicken are included in this system. Thus, it is assumed that these meats are weakly separable from other food products and all other goods.

In order to address the objectives of this study, measures of consumer concerns over cholesterol consumption and food safety are introduced in the demand system as scaling factors, as done by Piggot et al in their study on advertising and meat consumption. Thus, the intercept term is defined as follows,

$$\alpha_0 = \sum_k \beta_{1k} Z_{1t-k} + \sum_k \beta_{2k} Z_{2t-k}, \qquad \textbf{(2)}$$

where Z_{1t-k} is a measure of consumer information on beef safety and Z_{2t-k} is a measure of consumer information on dietary health (cholesterol). In each case, they are introduced with lags to account for the potential of the lagged influence of these variables on consumption. Their effects over time, though, are expected to differ. Since quarterly data were used in the estimation process, quarterly dummy variables were also introduced as shift variables to account for seasonal variation in consumption. This is consistent with the models specified by Burton and Young and Kinnucan et al.

Information on beef safety typically arises during a crisis, when some food borne illness incidence occurs. Though the events are sporadic in occurrence, they are widely reported given the gravity of these events, which sometimes do involve death. Thus, these food safety concerns constitute a potential immediate threat to the consumer. In contrast, consumer information on diet and health, specifically cholesterol information, has been evolving gradually since the 1950's. Consumer health in this case is potentially threatened only after repeated and long term

consumption. Thus, the impact of beef safety concerns should be realized within a shorter period of time than the impact attributable to cholesterol information. Interestingly, Kinnucan et al found a high rate of decay for health information.

Given the findings by Kinnucan et al and Capps and Schmitz on the largely insignificant impact of generic advertising, this study does not incorporate an advertising variable in the model to be estimated. The data needed for estimation is reviewed next.

Data and Methods

Price and quantity data for chicken, pork, and beef were obtained from the USDA's *Livestock and Poultry Situation and Outlook Report*. Prices were measured in real terms and quantity was measured in pounds per capita. Quarterly data were collected for 1987 through 1997.

The food safety information index, Z_1, was constructed by counting the number of Associated Press articles filed on E. coli and salmonellosis contamination in beef and BSE. The number of articles which might be described as positive were subtracted from the number of negative articles on the hazards posed by these pathogens.

Health information (Z_2) was proxied by per capita shell egg consumption, measured in pounds at retail. It is argued that since both Brown and Schrader and Wang, Jensen, and Yen established that there is a significant relationship between shell egg consumption and health information, it is acceptable to use shell egg consumption directly as a proxy. In a similar manner, Gao and Shonkwiler use the ratio of per consumption of low fat milk to whole milk as an indicator of consumer concern over the link between fat and cholesterol consumption and heart

disease in a latent variable model of meat demand. Data on per capita shell egg consumption were also obtained from USDA.

Both the health information variable and beef safety variable were introduced in square root form to account for the diminishing marginal effect of additional information. Thus, just as advertising expenditures are expected to have a declining marginal effect, so too should health and food safety information.

The model was estimated using maximum likelihood seemingly unrelated regressions (SUR) to accomodate the imposition of the homogeneity and symmetry restrictions. The estimated model is discussed in the next section.

Results and Implications

Preliminary analysis revealed that the beef safety variable effect was realized entirely within the current period quarter. Lagged beef safety variables were not found to be significantly different from zero. In contrast, the effect of health information was found to persist over one lagged period. Thus, the model was estimated with contemporaneous beef safety and health information variables and a lagged health information variable. It was also found, like other meat demand studies, that there was evidence of seasonal variations in demand. Elasticities from the estimated parameters were computed using the formulas derived by Green and Alston and are reported in tables 1 and 2.

Table 1 indicates that all own price elasticities are significantly different from zero and negative. Among the cross price elasticities, only one case was found where the expected substitute relationship was observed. Among the other cross price elasticities, significant,

negative elasticities were obtained, suggesting that the meats are complements. However, once the Hicksian or utility constant elasticities are computed, these complementary relationships are not as pervasive. The Hicksian elasticities are presented in table 2. Only the relationship between chicken and pork continues to have a negative, albeit insignificant, elasticity. In general, the Hicksian elasticities are similar in magnitude to those obtained by Kinnucan et al and Capps and Schmitz.

In examining the expenditure elasticities in table 1, it is seen that this parameter is significant for all three meats at the 10 percent level. The beef expenditure elasticity was measured at about 1.0, again similar to those obtained by Kinnucan et al and Capps and Schmitz. The expenditure elasticities for pork and chicken, though, are quite different from these other studies.

The estimated price and expenditure elasticities are in general plausible and consistent with estimates obtained by other researchers. This provides some confidence in reviewing the findings for the central focus of this paper, the effect of food safety and health information on meat demand.

From the estimated elasticities presented in table 1, it is seen that food safety information has a significant negative impact on beef consumption, when this coefficient is evaluated at the 10 percent level under a one-tailed test. As hypothesized, increased coverage of beef contamination events and beef safety concerns reduces beef consumption, although in a very modest manner. Specifically, a one percent increase in the number of AP news articles, reduces beef consumption by 0.013 percent. This modest impact, perhaps rationalizes the jury decision in the Oprah Winfrey case. The beef safety stories appear to have no affect on either pork of chicken consumption.

Though in each case, the estimated elasticity was positive in sign, suggesting that an increase in AP news stories increases pork and chicken consumption.

The health information proxy (per capita shell egg consumption) is found to have a significant, negative affect on chicken consumption. Thus, a one percent decline in shell egg consumption results in a 0.158 percent increase in chicken consumption. Increased consumer information on cholesterol (decline in shell egg consumption) is also seen to result in a decline in beef consumption. The beef health information index is estimated at 0.063. Again, health information is not seen to significantly influence pork consumption. These findings are similar to those obtained by Kinnucan et al, at least in terms of the level of significance and sign.

The results indicate that beef safety information has an impact, although very modest, on beef consumption. Based on a comparison of the estimated elasticities, it appears that the effects of increased information on cholesterol dominates food safety concerns. However, the health information measure does not show up as pronounced in this study as it did in Kinnucan et al. In their analysis, it was seen that the health information elasticity for poultry was larger in magnitude than the poultry own price elasticity of demand and the poultry cross price elasticity of demand with respect to beef prices. In this study, the chicken health information elasticity was smaller in magnitude than each of these other elasticities. This discrepancy could be due to the different measures used in each study to proxy consumer information on cholesterol.

These results suggest that beef producers need to maintain efforts at modifying their product with regard to both safety and health attributes. Each of these factors was found to influence beef demand. Although the effect of safety concerns on beef demand was very modest and of only marginal significance, the evidence from the United Kingdom suggests that it should

not be dismissed. More compelling evidence, consistent with other studies, was found to support further efforts at modifying the health attributes of the product. Still, the estimated parameters obtained here can be used as a rough guide on the level of resources, which should be allocated through beef producer organizations to address these issues.

The Dorfman-Steiner result suggests that the ratio of advertising expenditures to sales revenue should equal the ratio of the advertising to demand elasticities (Ward). The elasticities obtained here would suggest that the industry should spend an amount equal to 1.2 percent of industry sales to address beef safety matters. Similarly, an amount equal to 5.7 percent to of industry sales should be spent to ameliorate consumer concerns over the healthfulness of beef. Currently, these suggested expenditure levels far exceed the level of assessments paid by beef producers into their promotion and research organizations. Their assessments typically are less than one percent of producer returns. However, given the reach of these problems, which affect the returns of downstream marketing partners, perhaps other product handlers should contribute to these efforts.

It should be noted that activities directed by the Cattlemen's Beef Promotion and Research Board have already been directed at health and safety issues. Allocation to these activities and related activities accounted for less than 28 percent of the assessments collected by this organization during 1998. Promotion expenditures accounted for 63 percent of all collected assessments. Given the recent studies which question the effectiveness of promotion expenditures, this of allocation should possibly be reconsidered. Greater attention should possibly be given to addressing health and safety issues.

Table 1. Marshallian Price, Expenditure, and Information Elasticities of Demand

	Quantity of:		
With Respect to:	Beef	Pork	Chicken
Beef Price	-1.106**	0.451**	-0.291*
	(-9.144)	(2.794)	(-1.927)
Pork Price	0.069	-0.708**	-0.477**
	(0.793)	(-5.331)	(-4.644)
Chicken Price	-0.045	-0.171*	-0.710**
	(-0.586)	(-1.801)	(-5.542)
Meat Expenditure	1.082**	0.428*	1.477**
	(6.441)	(1.820)	(6.969)
Safety Information	-0.013+	0.014	0.014
	(-1.393)	(0.973)	(1.156)
Health Information	0.063**	0.020	-0.158**
	(5.310)	(0.975)	(-8.722)

The values in parentheses are t-ratios. Two and one asterisks denote significance at the five and ten percent levels, respectively, for two-tailed test; a plus sign denotes significance at the ten percent level for a one-tailed test.

Table 2. Hicksian Price Elasticities of Demand.

	Quantity of:		
With Respect to:	Beef	Pork	Chicken
Beef Price	-0.570**	0.664**	0.441**
	(-5.484)	(5.186)	(3.449)
Pork Price	0.360**	-0.593**	-0.080
	(5.186)	(-5.328)	(-0.972)
Chicken Price	0.210**	-0.070	-0.361**
	(3.449)	(-0.972)	(-3.275)

The values in parentheses are t-ratios. Two and one asterisks denote significance at the five and ten percent levels, respectively, for two-tailed test; a plus sign denotes significance at the ten percent level for a one-tailed test.

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