Identifying Factors Influencing Beef, Poultry, and Seafood Consumption

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The dominant pattern in U.S. meat consumption over the past two decades has been characterized by a stable increase in per-capita consumption of poultry and a significant decrease in per-capita consumption of beef. Meanwhile, per-capita consumption of seafood has increased steadily despite the fact that the concurrent price index for seafood has risen faster than for any other animal food commodity (Wessells and Anderson 1995). Efforts have been made to investigate the driving forces behind the changes in the meat-consumption patterns. Many studies have confirmed the existence of structural changes due to food risk perception, nutritional consideration, and health concerns (e.g., Capps and Schmitz 1991), while some researchers think that increased demand for convenience rather than increased health awareness contributed to poultry's success (e.g., Anderson and Shugan 1991).

The majority of previous studies based their analyses on aggregated data. Beyond the aggregated per-capita statistics, little is known about individual differences in meat consumption. What demographic and economic factors affect meat consumption? And in what way? Do consumers' health conditions, previous consumption experiences, and perception of the food safety regulations affect meat consumption? Answers to these questions help to effectively exploit the market. This study investigates factors affecting beef, poultry, and seafood consumption frequency using data from a survey of meat consumption in the United States.

A Count-Data Model

Food-consumption studies have traditionally focused on analyses of expenditures on consumption and volume consumed. Recently, economists have used count-data models extensively in food consumption studies to model the discrete aspects of consumption behavior. Count-data models are appropriate for the data used in this study because the recorded observations of the consumption frequency are integer values (Lin and Milon 1993; Cameron and Trivedi 1998).

The data contain some "zero counts," or responses of non-consumption. Zero counts deserve special treatment because they meaningfully partition the population into sub-populations (Cameron and Trivedi 1998). Zero counts in the consumption study of a specific food item may indicate discrete decisions of nonconsumption regardless of such economic factors as income and prices, while positive counts represent constrained consumption. Zero counts and positive counts (positive consumption) may be generated by different processes.

Efforts have been made to extend basic count-data models to explore the special meaning of zero counts (Gurmu 1998; Mullahy 1986; Pohlmeier and Ulrich 1995) and several modified count-data models have been developed to handle the issue of zero counts. Among all the extended count-data models, the zero-inflated and the double-hurdle count-data models are most frequently used in empirical studies. election between the basic and extended count-data models is usually done through-likelihood ratio tests.

Three types of discrete distribution—Poisson, geometric, and negative binomial distributions—are most frequently considered in count-data models. The Poisson-regression model is the basic count-data model and is probably the one most frequently used. Although the Poisson-regression model is popular and has played a pivotal role in modeling count data, it has been criticized for its implicit assumption that the variance of the dependent variable equals its mean (Green 1993). In empirical studies the conditional variance tends to be greater than the conditional mean, a phenomenon called *overdispersion* in the data. If the struc-

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ture is correct, but overdispersion is present, then the estimates from the Poisson regression are consistent but inefficient (Cameron and Trivedi 1990). This restriction is relaxed in the geometric distribution and the negative binomial distribution. Each of these distributions, as Mullahy pointed out, has its own strong as well as weak points, and Vuong's tests are often used to select among these three types of distribution.

Tests were conducted for selecting among the basic, the zero-inflated, and the double-hurdle count-data models, and for selecting among Poisson, negative binomial, and geometric-probability distributions. The basic count-data model with negative binomial distribution was chosen for the empirical analysis.

The negative binomial count-data model can be represented by its probability distribution

$$(1) \quad pr(Y_i = j) = \frac{\Gamma\left(j + \frac{1}{\alpha}\right)}{\Gamma(j+1)\Gamma\left(\frac{1}{\alpha}\right)} (\alpha\lambda_i)^j [1 + \alpha\lambda_i]^{-(j+1/\alpha)}$$

where Y_i is the i^{th} observation on the dependent variable, j = 0, 1, 2,...,J denotes the possible values of y_i, $\lambda = \exp(X_i ß)$, X is a set of explanatory variables, ß is a set of parameters to be estimated, and is a nuisance parameter to be estimated along with ß.

The first two moments are:

$$(2) \quad E(Y_i|X_i) = \lambda_i = \exp(X_i \beta)$$
$$\text{var}(Y_i|X_i) = \lambda_i(1 + \alpha\lambda_i)$$

Given $\alpha>0$, the variance is greater than the mean. The log-likelihood is

$$(3) \quad \ln L = \ln\left(\Gamma\left(j + \frac{1}{\alpha}\right)\right) - \ln(\Gamma(j+1)) - \ln\left(\Gamma\left(\frac{1}{\alpha}\right)\right) + j\ln(\alpha) + jX_i\beta - \left(j + \frac{1}{\alpha}\right)\ln(1 + \alpha\lambda_1).$$

Data and Survey

The data were from a nationwide telephone survey of 740 households on meat consumption conducted by the Survey Research Center of the University of Georgia in December 1999 and January 2000. The survey instruments were developed by a group of agricultural economists and survey-design experts.

In order to enhance the reliability of the information obtained from the survey, primary grocery shoppers of the households were requested to answer the questions. Vegetarians were excluded from the survey and more than 99% of the respondents ate meat at least once a week. Respondents were asked questions in several broad sections including frequencies of beef, poultry, and seafood consumption; perceptions about the adequacy and the enforcement effectiveness of food-safety regulations; previous meat-consumption experience; health condition; and a set of questions regarding their demographic and economic status.

The results show that the mean frequencies of beef and poultry consumption were very close, about 12 times per month for each. The mean frequency of seafood consumption was about 5 times a month, much lower than that of beef and poultry consumption. The participation rate for seafood consumption was also lower than that of beef and poultry consumption. About 25% of the respondents reported that they had never or rarely eaten seafood, while the non-participation rates for beef and poultry consumption were about 5% and 2%, respectively. Impressively, only about 16% of the respondents thought that the safety regulations were both adequate and effectively enforced. On the other hand, about 47% of the respondents thought the safety regulations were both inadequate and ineffectively enforced while 24% thought the regulations were adequate but not effectively enforced. About 6% of the respondents reported that they had the experience of being sick from meat consumption, an alarming number. Table 1 presents the descriptive statistics of the variables used in the study.

Results

The estimation results of beef consumption, poultry consumption, and seafood consumption are presented in Table 2. Note that the variables Safety1 and Safety4 are not included in the estimation. Safety1 is used as the benchmark variable against which the effects of Safety2 and Safety3 are measured. Safety4 contains too few observations, and thus was excluded from the estimation.

The results show an inverse relationship between age and beef consumption. The negative effect may be due to health concern about consumption of beef. It is well known that beef is high in cholesterol and that too much cholesterol may cause

Table 1. Definitions and Descriptive Statistics of the Variables Used in Empirical Model Estimation.

Variables	Description	Mean
Age	Actual age of respondents	49.62
Gender	1 = male, 0 = female	0.30
Education	1 = less than high school 2 = high school 3 = some college education 4 = college degree 5 = post-graduate or professional	3.11
White	1 = white, 0 otherwise	0.81
Fullemploy	1 = full employed, 0 otherwise	0.43
Lowincome	1 = less than $50,000 a year, 0 otherwise	0.44
Highincome	1 = $75,000 or more a year, 0 otherwise	0.14
Exelhealth	1 = excellent health condition, 0 otherwise	0.41
Poorhealth	1 = poor health condition, 0 otherwise	0.12
Famlysize	Number of household members	2.99
Meatsick	1 = experience of being sick from meat consumption in the past 12 months, 0 otherwise	0.06
Safety1	1 = consider safety regulations both adequate and effectively enforced, 0 otherwise	0.16
Safety2	1 = consider safety regulations are neither adequate nor effectively enforced, 0 otherwise	0.47
Safety3	1 = consider safety regulations are adequate, but not effectively enforced, 0 otherwise	0.24
Safety4	1 = consider safety regulations are inadequate, but effectively enforced, 0 otherwise	0.05

arteriosclerosis and heart problems. As people age they face a growing risk of suffering from arteriosclerosis and heart diseases and they tend to pay a special attention to health aspects of their diet. Hence, as people age they tend to eat beef less frequently. Age was also found to have a negative effect on poultry consumption. Generally, poultry contains less cholesterol than beef, but red poultry meat is also rich in cholesterol, and the fatty parts contains unhealthy nutritional elements.

Contrary to beef and poultry consumption, the age variable bears a positive sign in the estimation of seafood consumption. Although the effect is not statistically significant at commonly accepted significance levels, a t-ratio of 1.35 should not be neglected. For decades, seafood has been promoted by nutritionists and media as a healthy food and consumers are well aware of the nutritional value of seafood. Seafood is high in protein; vitamins A, D, and B-complex; and contains cholesterol-reducing Omega-3 fatty acids. It helps to prevent heart disease, lowering blood pressure and supplying eicosapentaenoic acid (Anderson and Anderson 1991; Kinsella 1988). As people age, they may tend to pay more attention to the health benefits from seafood consumption.

Table 2. Estimation Results of Beef, Poultry, and Seafood Consumption.

Variables	Beef Consumption		Poultry Consumption		Seafood Consumption	
	Coefficients	T-ratio	Coefficients	T-ratio	Coefficients	T-ratio
Constant	1.2871	8.61***	1.3694	10.18***	0.1497	0.75
Age	-0.0062	-4.45***	-0.0029	-2.07**	0.0028	1.35
Gender	0.2222	3.981***	-0.1153	-1.83*	0.0524	0.61
Education	-0.0628	-2.75***	0.0117	0.51	0.0509	1.62*
White	0.1765	2.67***	-0.1579	-2.43**	-0.2362	-2.53***
Fullemploy	0.0839	1.47	0.0461	0.88	0.1113	1.34
Lowincome	-0.0493	-0.84	-0.0933	-1.61	-0.0797	-0.99
Highincome	-0.0732	-0.92	-0.1143	-1.34	0.0778	0.64
Exelhealth	-0.0946	-1.72*	-0.0525	-0.93	0.5467	0.69
Poorhealth	-0.0438	-0.52	-0.3239	-2.89***	-0.3659	-2.07**
Famlysize	0.0482	3.95***	-0.0124	-1.12	-0.0467	-2.98***
Meatsick	0.0882	0.76	0.0176	0.16	0.2486	2.16**
Safety2	-0.1357	-2.27***	0.0024	0.04	-0.0025	-0.03
Safety3	-0.1642	-2.42***	0.0535	0.81	0.1663	1.72*

* significant at 0.1 level.
** significant at 0.05 level
*** significant at 0.01 level

Gender was found to have significant effects on meat consumption. Males tended to eat beef more frequently than did females. Not only is the effect statistically highly significant, the estimated coefficient on gender has the largest value among all the included variables, implying gender had the largest impact. On the contrary, females ate poultry more frequently than did males. As in beef consumption, the estimated coefficient on gender had the largest value among all the factors considered.

From the health point of view, we expected education to have a negative effect on beef consumption and a positive effect on seafood consumption due to reasons described above. As expected, the results show that more-educated people tended to eat beef less frequently than did less-educated people. On the other hand, more-educated people ate seafood more frequently than less educated people. A plausible explanation is that more educated people may be better informed about the potential health risks of consuming cholesterol-rich beef and about the health benefits of consuming seafood, especially lesser known benefits such as lowering the probability of diabetes, arthritis, bronchial asthma, psoriasis, and certain cancers (Anderson and Anderson 1991; Nettleton 1987).

Household size was found to have a positive effect on beef consumption but a negative effect on seafood consumption. Household size and the age structure of household members are closely related in a special way. Generally, in a household of one or two persons, the members of the household tend to be adults, either a single adult or a couple. In a household of three or more people, it is likely that one or more members of the household are children. Nutritional needs are not necessarily always the same for adults as for children. For example, children need much more cholesterol than do adults. The difference in nutritional needs may be a plausible explanation for the effects of family size.

Ethnic status had a significant effect on the consumption of all the three kinds of meat. Whites tended to eat beef more frequently and poultry and seafood less frequently than did non-whites. Cultural differences and traditions may be a major driving force behind the effect of ethnic status on meat consumption. For example, a respondent immigrated from Japan is likely to eat seafood more frequently but beef less frequently than is a respondent immigrated from a European country.

Health condition and consumption experience are also major factors affecting meat consumption. Those who claimed to be in excellent health tended to eat beef less frequently, while those who thought their health was poor or fair tended to eat poultry and seafood less frequently. Interestingly, the experience of becoming sick from eating meat in the past 12 months did not negatively affect meat consumption, but encouraged seafood consumption.

Generally, beef is not as safe as poultry and seafood in terms of getting sick from food consumption. According to the Centers for Disease Control, each year about 1 out of 13,000 people in the United States get sick from E-Coli, which is often associated with eating ground beef. In 1988, out of a total of 44 recalls of meat products at least 25 were related to beef, while only 8 were related to poultry. Risk of getting sick from food consumption is closely related to food-safety regulations and their enforcement. Adequate safety regulations and effective enforcement would significantly lower the probability of getting sick from the consumption of high-risk foods such as ground beef. As expected, lack of confidence in the adequacy of food regulations and the effectiveness of their enforcement had a negative effect on beef consumption. On the contrary, lack of confidence in the enforcement effectiveness of food-safety regulations encouraged seafood consumption. However, perception about the adequacy and enforcement effectiveness of food-safety regulations did not have a significant impact on poultry consumption. This may be due to the fact that poultry is relatively safe.

Conclusion

Meat consumption in the United States has experienced dramatic changes in the past two decades. Insights about factors influencing household meat consumption help to understand the market better, and thus to more effectively exploit the market. This study has found that age, education level, gender, ethnic status, health condition, and consumption experience all had a significant impact on meat consumption. Respondents' perception of the inadequacy and the enforcement ineffectiveness of food-safety regulations had a negative impact on beef consumption frequency, implying that beef consumption can be increased by enhancing consumer confidence in food-safety regulations. The results imply (though indirectly) that nutritional considerations and health concerns do play a role in meat consumption.

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