Consumption of Pork Products: Now and to the Year 2020

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Abstract

Data from the U.S. Department of Agriculture's 1994-96 and 1998 Continuing Survey of Food Intakes by Individuals are used to describe pork consumption patterns as well as to estimate a censored demand system for pork cuts. The descriptive analysis fills the void about basic information on who consumes pork, how much, and where. A censored system of four pork cuts is estimated by a maximum likelihood procedure and used to predict consumption of pork products through the year 2020.

Key Words: Censored dependent variables, CSFII, pork, Tobit system.

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Pork, “the other white meat”, is one of the most desired meats in the United States. In 2002, pork accounted for 40 percent of all red meats consumed (U.S. Department Agriculture (USDA), 2003). As the fourth largest sector among all U.S. farm commodities, the hog industry continues to grow in farm size and undergo changes in the way hogs are produced, managed, and marketed. A record production of 20.4 billion pounds of pork is expected to reach the market this year (USDA, 2004).

While we know a great deal about pork production, there is little or no data to show the basic facts about pork use except total disappearance. In fact, very little is known about the demographics of pork consumption, how much is consumed, and where pork is consumed. A better understanding of these three key factors will enable the industry to design effective marketing strategies and to predict future demand. For example, the changing racial/ethnic landscape in the United States and the graying of Americans are expected to influence future pork demand (Lin et al, 2003). This study analyzed the most recent data from the USDA’s food consumption survey to examine the factors affecting pork consumption. A descriptive analysis was conducted to describe the distribution of pork consumption, both fresh and processed, across different marketing sectors, geographic regions, and population groups. In addition, a censored demand system was estimated for four cuts of pork, and the estimated system was used to forecast consumption of pork products through the year 2020.

Data

The USDA has conducted periodic food consumption surveys in the United States since the 1930’s. The most recent food consumption surveys, the 1994-96 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII 1994-96 and 1998) and the 1994-96 Diet and Health Knowledge Survey (DHKS), conducted by USDA’s Agricultural Research Service (ARS), provide the data for this study (USDA 2000). Each year of the 1994-96 CSFII survey comprises of a nationally representative sample of non-institutionalized persons residing in the United States. As a supplemental survey to the 1994-96 CSFII, the 1998 CSFII was conducted to increase the 1994-96 CSFII sample for children.

In the CSFII, two nonconsecutive days of dietary data for individuals of all ages were collected three to ten days apart through in-person interviews using 24-hour recalls. The 1994-96 CSFII data provide information on the food intakes of 15,303 individuals, while the 1998 CSFII data provide intake information on 5,559 children up to 9 years of age. The respondents in the CSFII provided a list of foods consumed as well as information on where and how much of each food was eaten.

After the respondents reported their first day of dietary intake, an adult 20 years old or above was randomly selected from each household to participate in the DHKS. The DHKS questions cover a wide range of issues, including self-perceptions of the adequacy of nutrient intakes, awareness of diet-health relationships, knowledge of dietary recommendations, perceived importance of following dietary guidance, use and perceptions of food labels, and behaviors related to fat intake and food safety. Out of 7,842 households eligible to participate in the DHKS, respondents from 5,765 households completed the survey.

The ARS created several technical databases to support use of CSFII data. More than 7,000 food items were reported being consumed by the CSFII respondents. Each food is described and a recipe is provided in the recipe database. ARS also developed the Food Commodity Intake Database (FCID) for the Environmental Protection Agency (EPA) to estimate human exposures to pesticide residues through the consumption of foods and beverages (EPA 2000). The FCID provides data on the edible amount of over 500 agricultural food commodities contained in foods reported being eaten in CSFII. The description of the food items, their recipes, and the FCID database were used for this study in classifying pork cuts and calculating the amount of pork consumed.

Socioeconomic and demographic data for the sample households and their members are also reported in CSFII. These personal data were combined with consumption data to describe pork consumption patterns—who eats pork, how much, and where. This descriptive analysis was conducted by incorporating sample weights to represent the total U.S. market. Additionally, a censored demand system for four pork cuts was estimated and served as the basis to project pork consumption through the year 2020. We were interested in examining the role of dietary knowledge in pork consumption, so the demand analysis was conducted using the data provided by the adults who completed the DHKS.

U.S. Pork consumption: who, what, how much, and where

The CSFII data were used to estimate the distribution of pork consumption by economic and demographic characteristics. According to USDA's food disappearance data, each American consumed an average of 66 pounds of pork, carcass weight, per year during the 1994-98 period. This per capita consumption was combined with market distribution to derive per capita pork consumption by economic and demographic characteristics.

In this study, pork was separated into two main product forms--fresh and processed. The consumption of individual cuts within each form could also be estimated with CSFII data and its associated databases. For fresh pork, individual cuts included pork chops, pork steaks, ribs, fresh-ham, other fresh pork, and pork parts. The processed pork category could be further disaggregated into lunchmeats, hot dogs, bacon, sausage, smoked ham, and other processed pork.

Due to space limitation, we described pork consumption in terms of market distribution and per capita consumption (in parentheses) for the two aggregated product forms—fresh and processed (table 1).

[insert table 1 here]

CSFII data indicate that 38 and 62 percent (25 and 41 pounds per person) of pork were consumed as fresh and processed, respectively, during the 1994-98 period. Pork was purchased mainly at retail stores (78 percent) and considered as at-home foods. A larger proportion of fresh pork was purchased for at-home consumption (82 percent), compared with the 76 percent for processed pork. Restaurants, including fast food places, represented the bulk of pork consumed away from home with a 17-percent share of total pork consumption (11 pounds per person per year). Consumers consumed an average of 7 pounds of processed pork and 4 pounds of fresh pork at restaurants during 1994-98.

There were regional differences in pork consumption. The pork market was strongest in the Midwest region (75 pounds per person per year) and weakest in the West region (53 pounds). The Midwest accounted for 24 percent of the U.S. population and 26, 27, and 27 percent of fresh, processed, and total pork consumption, respectively. Fresh pork was favored in the West, while processed pork was favored in the South. Pork was favored by rural consumers, who represented 21 percent of the U.S. population and 25 percent of pork consumption.

Males consumed more pork, both fresh and processed, than did females (84 pounds versus 48 pounds). Pork consumption initially increased with age, peaking among the 40-59 age group (99 pounds for men and 54 pounds for women), and then declined.

In the CSFII survey, households were classified into three income brackets using the Federal poverty guidelines. The poverty guideline was developed by the U.S. Department of

Health and Human Services for the implementation of Federal food programs. Some Federal food programs, such as the Food Stamp Program, have used 130 percent of the poverty level as the eligibility criterion for participation. CSFII data indicate that lower-income consumers ate more pork than their higher-income counterparts. Individuals in households with income eligible for the Food stamp program consumed about 70 pounds of pork per year, compared to 68 and 62 pounds consumed in higher income households.

The 1994-96 and 1998 CSFII were based on populations from the 1990 Census. At that time, Hispanics and Blacks accounted for 11 and 13 percent of U.S. population, respectively. The 2000 Census results show the United States has been undergoing rapid demographic expansion. Pork was favored by Blacks, who consumed about 82 pounds per person per year, followed by 74, 64, and 57 pounds consumed by other race, Whites, and Hispanics, respectively. Blacks had a strong preference for processed pork (54 pounds) and consumers of other races favored fresh pork (49 pounds).

The Censored Demand System for Pork by Cut

In this study, we also estimated a demand system for pork cuts and used it to forecast pork demand through the year 2020. Four cuts of pork were specified: fresh pork (chop, loin, rib, ham, and other fresh cuts, excluding offal or byproducts), brunch meats (includes lunch meats, hot dogs, bacon, and sausage), smoked ham, and other pork. The CSFII data indicate that over the two-day survey period, 23, 35, 21, and 38 percent of the DHKS respondents consumed fresh pork, lunchmeats, smoked ham, and other pork.

Because the dependent variables are censored (i.e., some individuals did not consume certain pork cuts during the survey period), standard regression procedures not accommodating such censoring produce statistically biased empirical estimates (Amemiya). To accommodate such censoring, we used a censored multi-equation system procedure (Amemiya). Using a vector $\mathbf{x}$ to represent explanatory variables, a linear functional form to approximate each deterministic demand function, and a random error ε_i to capture the unobservables, we consider a system of censored equations (Amemiya) such that

$$q_i = \max(\mathbf{x}'\boldsymbol{\beta}_i + \varepsilon_i, 0), \quad i = 1, 2, \ldots, n, \tag{1}$$

where q_i are quantities and $\boldsymbol{\beta}_i$ are vectors of parameters.

To describe the presentation procedure, consider, without loss of generality, a sample regime in which the first k goods are consumed, with observed n-vector $[q_1, \ldots, q_k, 0, \ldots, 0]'$. Denote the random error vector as $\xi \equiv [\xi_1', \xi_2']'$, partitioned such that $\xi_1 \equiv [\varepsilon_1, \ldots, \varepsilon_\ell]'$ and $\xi_2 \equiv [\varepsilon_{\ell+1}, \ldots, \varepsilon_n]'$, and assume ξ is distributed as n-variate normal with zero mean and $n' \; n$ covariance matrix $\Sigma \equiv [\rho_{ij}\sigma_i\sigma_j]$, where ρ_{ij} are the error correlation coefficients and σ_i are the error standard deviations. Denote $\mathbf{u} \equiv [-\mathbf{x}'\boldsymbol{\beta}_{\ell+1}, -\mathbf{x}'\boldsymbol{\beta}_{\ell+2}, \ldots, -\mathbf{x}'\boldsymbol{\beta}_n]'$. Then, the censoring mechanism (1) implies the regime-switching condition

$$\xi_2 \leq \mathbf{u},$$

from which the likelihood contribution of this demand regime can be constructed as

$$L_c(\mathbf{q}) = f(\xi_1) \int_{\{\xi_2 : \xi_2 \leq \mathbf{u}\}} g(\xi_2 \mid \xi_1) \, d\xi_2, \tag{2}$$

where $\xi_1 {}^{\circ}\ [q_i -\ \mathbf{x}¢\boldsymbol{\beta}_i]$ is a ℓ-vector, $f(\xi_1)$ is the marginal density of ξ_1, and $g(\xi_2 \mid \xi_1)$ is the conditional density of ξ_2 given ξ_1. The densities of $f(\xi_1)$ and $g(\xi_2 \mid \xi_1)$ are also normal by the normality assumption of ξ, with moments following from properties of the multivariate normal distribution (Kotz, Johnson and Balalrishnan). In (2), the term $f(\xi_1)$ is identical to that of a ℓ-

equation regression model with contemporaneously correlated Gaussian disturbances (Davidson and MacKinnon, pp. 315–319), and the integral $\int_{\{\xi_2:\,\xi_2 \le \mathbf{u}\}} h(\xi_2 \mid \xi_1)\, d\xi_2$ is an $(n-\ell)$-dimensional cumulative distribution function (cdf), which upon standardization, simplifies to the standard multivariate normal cdf as in the multinomial probit model (Daganzo). Thus, the computational burden of estimating the censored system amounts to that of a non-censored equation system and a multinomial probit model combined. The sample likelihood function is the products of the likelihood contributions (2) over the sample units. The unknown parameters are β_i, σ_i $(i = 1, 2, \cdots, n)$ and ρ_{ij} for $i > j$.

Estimation Results

Maximum-likelihood estimation was carried out by programming the log-likelihood function in Gauss. Normal probability integral up to dimension three were evaluated with a numerical procedure (Kotz, Johnson, and Balalrishnan, pp. 121–145), and for 26% of the sample (or 1488 individuals), four-level probability integrals were evaluated with a smooth probability simulator known as the GHK simulator (Hajivassiliou).

The effects of explanatory variables were examined further by differentiating the unconditional means of each dependent variable. For each dependent variable, the unconditional mean of the dependent variable is (McDonald and Moffitt)

(3) $$E(q_i) = \Phi(\mathbf{x}'\beta_i / \sigma_i)\mathbf{x}'\beta_i + \sigma_i \phi(\mathbf{x}'\beta_i / \sigma_i).$$

Elasticities with respect to each continuous explanatory variable were derived by differentiating (3), and then evaluating at the sample mean of all variables. The effect of each dummy variable is calculated as the difference in the unconditional mean from a finite change in the variable, from zero to one, holding other variables constant. For statistical inference, standard errors for these effects of variables are calculated by the delta approximation method (Spanos).

The explanatory variables in the demand system included household income, dietary knowledge, household size, household type, age, gender, age, race/ethnicity, employment status, and seasonal/location dummy variables. The variable names and definitions and the sample statistics are given in table 2. All explanatory variables, except dietary knowledge, are self-explanatory. We used 12 DHKS questions to measure dietary knowledge. Five of these questions reflect an individual's knowledge of recommended servings for the five food groups specified in the Food Guide Pyramid (grains, dairy, meats, fruits, and vegetables). The remaining seven questions probe an individual's awareness of any health problems caused by dietary related behavior, such as eating too much fat or not eating enough fiber. The dietary knowledge was derived by summing correct answers to the recommended servings (in range) and the number of diet-health relationships of which the respondent was aware. The estimates of parameters and elasticities (and their standard errors and significance levels) are given in table 3.

[insert table 2]

[insert table 3]

The censored demand results suggest that household income had a negative effect on per capita consumption of brunch meats (including lunchmeats, hot dogs, bacon, and sausage) but had no significant effect on the consumption of the other three cuts—fresh pork, smoked ham, and other pork. Adults with higher dietary knowledge tended to consume less brunch meats and smoked ham. These findings are consistent with those reported in a study, which applied a different approach to the same data (table 15 and 16 in Lin et al).

Pork consumption was found to be quite stable across the four seasons of the year. Males consumed more pork than did females. Seniors (those of age 66 and older) consumed less pork than did younger adults. Pork demand was strongest in the Midwest region. Consumers in the Southern region had a strong preference for brunch meats. Consumers in the Western region consumed the least amount of smoked ham. Consumers living in non-metropolitan (rural) areas consumed more pork than did other consumers. Compared with other consumers, Asians (who account for the majority of the other race category of the descriptive analysis) consumed the largest amount of fresh pork but the least amount of the other three cuts of pork. The Blacks preferred consuming fresh pork, brunch meats, and other pork. The Whites consumed more smoked ham than did other consumers, while Hispanics preferred fresh pork but not brunch meats.

Future Pork consumption: 2000-2020

Note that CSFII and DHKS data used in the demand estimation were collected for 1994-96. The first step in forecasting pork consumption was to project the values of the exogenous economic, knowledge, social, and demographic variables that affect pork consumption. The projected values of some variables, in 5-year increments beginning with the year 2000, are reported in table 4. Values of other exogenous variables not in table 4 were assumed to remain constant at the mean values of the 1994-96 and 1998 CSFII sample data. A discussion of the future values of exogenous variables can be found in Lin et al.

[insert table 4 here]

An OLS model was fitted for dietary knowledge to forecast future dietary knowledge. The results, summarized in the last two columns of table 4, indicate that dietary knowledge rose with income and educational achievement, but declined with age. Dietary knowledge also varied by marital status, race, and the location of the respondent's residence. The predictions of dietary knowledge are shown in the last row of table 4.

Several assumptions were made to forecast pork consumption. First, consumers' preferences for pork were assumed to carry over from 1994-96 to 2020. Second, the analysis was based on a cross-section of data collected over a short period of time. Given that the surveys contain no price information, prices do not appear in the consumption equations. As such, relative prices were assumed the same for all households of the same region within a season and throughout the prediction period. Note that regional and seasonal dummy variables were included in the model, so that systematic price variations by region and season should have been captured. Third, there was an implicit assumption that as any individual moves from one demographic group (e.g., age) to another, his/her preferences immediately take on the characteristics of the new group.

The rates of change in per capita and total pork consumption among adults predicted for the 2000-2020 period are shown in figures 1 and 2. The U.S. population is expected to grow by 50 million people between 2000 and 2020. Per capita consumption of fresh pork was predicted to rise by 3.4 percent between 2000 and 2020, whereas per capita consumption of brunch meat, smoked ham, and other pork were predicted to fall by 7.5, 5.2, and 2.5 percent, respectively, during the 2000-2020 period.

[insert figures here]

The graying of the population and the changing racial/ethnicity landscape in the United States contributed to the predicted changes in per capita consumption. It was predicted that those older than 65 would increase their share of the U.S. population, and this age group (the base in regression) consumed the least amount of all four pork cuts (Lin et al). It was predicted that

Hispanics, Asians, and Blacks would increase their representation in the U.S. population. Compared to Whites, Hispanics consumed more fresh pork and other pork but less brunch meats and smoked ham, Asians consumed more fresh pork and less of other three pork cuts, and Blacks consumed less smoked ham but more of the other three pork cuts. During the 2000-2020 period, the U.S. population would age to the extent that those older than 65 would increase their representation at the expenses of each of these other three age groups, 20-35, 36-50, and 51-65.

Because of rising U.S. population, the total U.S. consumption of all four pork cuts was predicted to increase between 2000 and 2020. Among the four cuts, only fresh pork was predicted to exhibit increasing per capita consumption. Therefore, total fresh pork consumption was predicted to rise at a faster rate (22 percent over 20 years) than the other cuts (9 percent for brunch meats, 12 percent for smoked ham, and 15 percent for other pork). Combining the four cuts, the total U.S. pork consumption was predicted to rise by 15 percent between 2000 and 2020.

The predicted changes in per capita and total pork consumption are a result of predicted changes in economic and demographic conditions. The contribution of each factor to consumption can be traced through a decomposition analysis (see Lin at al). The contribution can be quite complex for some factors, such as income and age. Income and age affect pork consumption directly according to the censored demand system, and they also indirectly affect pork consumption through dietary knowledge. The decomposition analysis was not conducted for this study.

Conclusions

Data from the USDA's food consumption surveys conducted in 1994-96 and 1998 were analyzed to describe U.S. pork consumption patterns and to estimate a demand system for pork cuts, which was used to forecast pork consumption through the year 2020. The data show that processed market dominated the fresh market (68 percent versus 32 percent) and the at-home market dominated the away-from-home market (78 percent versus 22 percent). Our analysis shows that income and dietary knowledge had negative effects on the consumption of certain pork cuts. Further, pork consumption varied by a host of social and demographic factors, including race and age. As a result, the expected changing racial landscape and graying of the American population are expected to affect future pork market.

The estimated demand system for pork cuts and the predicted social, economic, and demographic conditions were used to predict the per capita consumption of the pork cuts. It should be noted that there are key assumptions underlying the predictions. We assumed that consumers' preferences for pork and relative pork prices would stay the same throughout year 2020. Over time, as consumers move from one demographic group to another (such as aging), they would take on the new group's consumption patterns. The results indicated that per capita consumption of fresh pork would rise but the consumption of processed pork would decline over the next two decades. However, the U.S. population is predicted to grow by an estimated 50 million people. As a result, between 2000 and 2020, the consumption of fresh pork was predicted to grow by 22 percent, followed by a 15 percent growth in other pork, 12 percent for smoked ham, and 9 percent for lunchmeats, hot dogs, bacon, and sausage.

References

Amemiya, T. "Multivariate Regression and Simultaneous Equation Models When the Dependent Variables Are Truncated Normal." *Econometrica* 42(1974):999–1012.

Daganzo, C. *Multinomial Probit: The Theory and Its Application to Demand Forecasting*. New York: Academic Press,1980.

Davidson, R., and J.G. MacKinnon. *Estimation and Inference in Econometrics*. Oxford, UK: Oxford University Press, 1993.

Environmental Protection Agency, Office of Pesticide Programs. *Food Commodity Intake Database*. CD-ROM, 2000.

Kotz, S., N.L. Johnson, and N. Balalrishnan. *Continuous Multivariate Distributions, vol. 1: Models and Applications*, 2nd ed. New York: John Wiley & Sons, 2000.

Lin, B.H., J Variyam, J. Allshouse, and J. Cromartie. *Food and Agricultural Commodity Consumption in the United States: Looking Ahead to 2020*, Washington, DC: U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 820, February 2003.

McDonald J.F., and R.A. Moffitt. "The Uses of Tobit Analysis." *The Review of Economics and Statistics* 62(1980):318–21.

Hajivassiliou, V.A. "Classical Estimation Methods for LDV Models Using Simulation." *Handbook of Econometrics*, vol. 4. R.F. Engle and D.L. McFadden, eds., chap. 40, pp. 2383–2441. Amsterdam: North-Holland, 1994.

Spanos, A. *Probability Theory and Statistical Inference: Econometric Modeling with Observational Data*. Cambridge, UK: Cambridge University Press, 1999.

U.S. Department of Agriculture. *Agricultural Statistics*. National Agricultural Statistics Service. U.S. Government Printing Office, Washington, D.C. 2003.

U.S. Department of Agriculture, Agricultural Research Service. *World Agricultural Supply and Demand Estimates*. WASDE -409: pp. 1-36. April 8, 2004.

U.S. Department of Agriculture, Agricultural Research Service. *Continuing Survey of Food Intakes by Individuals 1994-96 and 1998*. CD-ROM., 2000.

Yen, S.T., and B. Lin. "Beverage Consumption among US Children and Adolescents: Full-information and Quasi Maximum-likelihood Estimation of a Censored System." *European Review of Agricultural Economics* 29(2002):85−103.

Table 1. U.S. consumption of fresh and processed pork: market distribution and per capita

Item	Population share	All pork	Fresh market	Processed market
	Market share in percent (per capita consumption in pounds)			
Fresh: Processed			37.7 (24.9)	62.3 (41.1)
Food Sources:				
Home		78.1 (51.5)	81.8 (20.4)	75.8 (31.2)
Away from Home		21.9 (14.5)	18.2 (4.5)	24.2 (10.0)
Restaurant		17.1 (11.3)	15.4 (3.8)	18.1 (7.4)
Others		4.9 (3.2)	2.8 (0.7)	6.1 (2.5)
Census Region:				
Northeast	19.6	19.6 (65.9)	18.9 (20.3)	19.9 (45.7)
Midwest	23.5	26.6 (74.7)	26.0 (23.2)	26.9 (51.5)
South	34.9	36.1 (68.2)	32.2 (19.4)	37.9 (48.9)
West	22.0	17.7 (53.1)	22.8 (21.8)	15.3 (31.3)
MSA Status:				
Urban	31.8	30.4 (63.0)	34.1 (22.5)	28.6 (40.5)
Suburban	47.0	44.8 (62.9)	42.1 (18.8)	46.1 (44.1)
Non-metro (rural)	21.2	24.8 (77.3)	23.8 (23.6)	25.3 (53.7)
Race/Ethnic Origin:				
White, Non-Hispanic	72.5	70.4 (64.1)	61.1 (17.7)	74.8 (46.4)
Black, Non-Hispanic	12.6	15.6 (81.6)	16.8 (28.0)	15.0 (53.6)
Hispanic	10.6	9.1 (56.7)	11.9 (23.6)	7.8 (33.1)
Other races	4.4	4.9 (73.7)	10.3 (49.2)	2.4 (24.5)
Household Income as a Percentage of Poverty:				
Under 130 percent	19.2	20.2 (69.6)	21.4 (23.4)	19.7 (46.2)
131-350 percent	41.8	43.1 (68.1)	41.6 (20.9)	43.8 (47.2)
Over 350 percent	39.0	36.7 (62.0)	37.0 (19.9)	36.5 (42.1)
Gender and Age:				
Male, All	49.0	62.6 (84.4)	62.7 (26.9)	62.6 (57.5)
Male, 2-11	9.0	6.3 (46.1)	5.4 (12.6)	6.7 (33.5)
Male, 12-19	5.9	7.7 (85.6)	6.9 (24.6)	8.0 (61.0)
Male, 20-30	16.0	22.7 (93.5)	22.4 (29.4)	22.8 (64.1)
Male, 40-59	11.6	17.3 (98.5)	18.4 (33.3)	16.8 (65.2)
Male, 60 and over	6.7	8.7 (85.8)	9.6 (30.1)	8.3 (55.7)
Female, All	51.0	37.4 (48.4)	37.3 (15.4)	37.4 (33.0)
Female, 2-11	8.5	4.9 (38.3)	3.5 (8.6)	5.6 (29.6)
Female, 12-19	5.7	3.9 (45.7)	3.4 (12.5)	4.2 (33.2)
Female, 20-30	15.9	11.9 (49.5)	12.8 (16.9)	11.5 (32.5)
Female, 40-59	12.1	9.9 (54.1)	10.6 (18.4)	9.6 (35.7)
Female, 60 and over	8.6	6.7 (51.4)	6.9 (16.8)	6.6 (34.5)

Source: U.S. Department of Agriculture, Agricultural Research Service, 2000. 1994-96 and 1998 Continuing Survey of Food Intakes by Individuals.

Table 2. Variables definitions and descriptive statistics for the censored demand system

Variable	Definition	Mean	St. Dev.
Fresh Pork	Pork chop, loin, rib, ham, and other fresh cuts, excluding offal or byproducts (grams/day)	4.61	12.54
Lunch Meat	Lunch meat, bacon, and sausage (grams/day)	3.49	8.40
Smoked Ham	Smoked ham (grams/day)	3.83	10.69
Other Pork	A catch-all category for all other fresh and processed pork cuts (grams/day)	1.86	5.70
Knowledge	Scores of dietary knowledge (0-12)	8.14	2.20
Income	Household income, per capita (in $1,000).	16.02	13.70
HH Size	Number of household members.	2.59	1.46
HS	The respondent completed high school education but did not go to college (0,1).	0.27	0.44
HS plus	The respondent went to college but did not graduate with a degree (0,1)	0.31	0.46
College	The respondent completed a college degree (0,1)	0.22	0.41
Male	The respondent is male (0,1)	0.50	
Employ	The respondent is employed (0,1)	0.57	
Age35	The respondent aged 20-35 (0,1)	0.23	
Age50	The respondent aged 36-50 (0,1)	0.27	
Age65	The respondent aged 51-65 (0,1). Base = respondents aged 66 and over	0.27	
Black	The respondent is non-Hispanic Black (0,1). Base = non-Hispanic White.	0.11	
Hispanics	The respondent is Hispanic (0,1).	0.08	
Asian	The respondent is Asian Pacific Islander (0,1).	0.02	
Other	The respondent's race/ethnicity is none of the above nor White (0,1).	0.01	
HH type1	The household is dual-headed, with children (0,1)	0.28	
HH type2	The household is dual-headed, without children (0,1)	0.36	
HH type3	The household is single-headed (either male or female), with children (0,1).	0.04	
Midwest	The respondent resides in the mid-western states (0,1).	0.25	
South	The respondent resides in the southern states (0,1).	0.35	
West	The respondent resides in the western states (0,1). Base = Northeast.	0.20	
Non-Metro	The respondent resides in rural areas (0,1).	0.27	
Suburb	The respondent resides in a suburb (0,1). Base = central city.	0.44	
Quarter 1	The first day of intake falls in January - March (0,1).	0.22	
Quarter 2	The first day of intake fall in April - June (0,1).	0.26	
Quarter 3	The first day of intake fall in July - September (0,1). Base = the fourth quarter.	0.28	

Table 3. Maximum-Likelihood Estimates of Censored System of Equations

Variable	Fresh Pork		Brunch meat[1]		Smoked Ham		Other Pork	
	Estimate	Elasticity	Estimate	Elasticity	Estimate	Elasticity	Estimate	Elasticity
Constant	–83.32***		–22.05***		–50.43***		–16.82***	
	(8.38)		(3.52)		(8.13)		(2.32)	
Continuous Variables								
Income	0.07	0.03	–0.23***	–0.16***	–0.15	–0.06	0.00	–0.01
	(0.12)	(0.04)	(0.05)	(0.04)	(0.11)	(0.05)	(0.04)	(0.04)
Diet knowledge	–0.56	–0.11	–0.94***	–0.34***	–1.37**	–0.29**	–0.11	–0.06
	(0.64)	(0.12)	(0.28)	(0.10)	(0.65)	(0.14)	(0.17)	(0.10)
Household size	1.29	0.08	–0.23	–0.03	–2.02	–0.13	0.71*	0.13*
	(1.39)	(0.08)	(0.57)	(0.07)	(1.48)	(0.10)	(0.42)	(0.07)
Weekend	–1.17	–0.02	4.17***	0.10***	0.64	0.01	0.88	0.03
	(2.48)	(0.03)	(1.05)	(0.03)	(2.35)	(0.03)	(0.74)	(0.03)
Binary Variables								
Quarter 1	5.07	1.14	1.24	0.42	2.46	0.53	0.59	0.21
	(4.01)	(0.92)	(1.71)	(0.58)	(3.74)	(0.82)	(1.14)	(0.40)
Quarter 2	3.15	0.70	1.00	0.34	2.08	0.45	–0.42	–0.15
	(3.83)	(0.86)	(1.63)	(0.55)	(3.61)	(0.79)	(1.08)	(0.37)
Quarter 3	–1.55	–0.34	2.04	0.69	–1.47	–0.31	–1.40	–0.48
	(3.84)	(0.83)	(1.56)	(0.54)	(3.67)	(0.77)	(1.07)	(0.36)
Male	13.49***	2.95***	11.54***	3.84***	12.58***	2.68***	4.09***	1.43***
	(2.96)	(0.65)	(1.27)	(0.42)	(2.83)	(0.60)	(0.85)	(0.29)
Age35	1.34	0.30	0.45	0.15	1.24	0.27	5.98***	2.26***
	(4.96)	(1.10)	(2.11)	(0.71)	(4.76)	(1.03)	(1.42)	(0.58)

Age50	4.29	0.95	4.81***	1.66***	5.85	1.28	3.57***	1.30***
	(4.83)	(1.09)	(1.97)	(0.70)	(4.68)	(1.05)	(1.43)	(0.54)
Age65	5.71	1.28	3.64**	1.24**	3.97	0.86	2.71**	0.98**
	(4.23)	(0.97)	(1.80)	(0.63)	(4.11)	(0.91)	(1.25)	(0.46)
Midwest	8.28**	1.88**	8.16***	2.90***	2.45	0.53	4.76***	1.76***
	(4.18)	(0.98)	(1.81)	(0.68)	(3.86)	(0.84)	(1.15)	(0.45)
South	−3.43	−0.74	8.48***	2.94***	−1.51	−0.32	1.63	0.58
	(3.92)	(0.84)	(1.67)	(0.60)	(3.76)	(0.79)	(1.12)	(0.40)
West	2.46	0.55	2.05	0.70	−16.26***	−3.14***	1.50	0.53
	(4.54)	(1.02)	(2.02)	(0.70)	(4.36)	(0.76)	(1.30)	(0.48)
Non-metro	8.15**	1.84**	4.68***	1.61***	5.60	1.22	1.12	0.40
	(3.79)	(0.88)	(1.64)	(0.59)	(3.64)	(0.82)	(1.07)	(0.38)
Suburb	−1.06	−0.23	2.78*	0.93*	1.58	0.34	−0.21	−0.07
	(3.47)	(0.76)	(1.51)	(0.51)	(3.36)	(0.72)	(0.98)	(0.34)
Black	22.73***	5.80***	10.87***	4.12***	−10.09**	−1.99**	3.28***	1.22***
	(4.60)	(1.35)	(1.88)	(0.80)	(4.80)	(0.87)	(1.24)	(0.49)
Asian	40.41***	12.31***	−23.00***	−5.23***	−26.87**	−4.39**	−9.35**	−2.60**
	(10.03)	(3.99)	(5.60)	(0.78)	(13.14)	(1.57)	(4.17)	(0.88)
Other minority	13.67	3.36	−2.40	−0.77	−12.68	−2.38	−4.70	−1.47
	(12.21)	(3.35)	(5.96)	(1.84)	(12.73)	(2.09)	(4.71)	(1.30)
Hispanic	17.09***	4.24***	−8.61***	−2.54***	−1.18	−2.49	4.43***	1.69***
	(5.33)	(1.49)	(2.55)	(0.66)	(5.21)	(1.09)	(1.51)	(0.63)
HOUSEHOLD	3.10	0.69	−1.07	−0.35	11.02**	2.47**	−1.43	−0.49
	(5.29)	(1.19)	(2.15)	(0.71)	(5.08)	(1.20)	(1.53)	(0.52)
HH type 1	8.79**	1.96**	1.75	0.59	8.82***	1.92***	0.11	0.04
	(3.68)	(0.84)	(1.55)	(0.52)	(3.47)	(0.78)	(0.99)	(0.35)

HH type 1	4.37	0.99	–2.21	–0.71	9.14	2.11	0.47	0.17
	(7.92)	(1.86)	(3.13)	(1.97)	(7.11)	(1.78)	(2.16)	(0.77)
Employ status	3.89	0.85	–1.21	–0.40	1.33	0.28	–0.38	–0.13
	(3.37)	(0.73)	(1.44)	(0.48)	(3.33)	(0.71)	(0.99)	(0.35)
σ	75.14		33.86		68.29		21.80	
	(1.54)		(0.27)		(1.23)		(0.15)	
Log-likelihood	–39965.77							

1. Includes hot dog, bacon, and sausage.

Note: Asterisks***,** and* indicate significance at 1%, 5% and 10% levels, respectively.

Table 4. Projected economic, knowledge, social, and demographic variables, 2000-2020

Variables	2000	2005	2010	2015	2020	Fitted dietary knowledge	
Exogenous variables						Coeff.	t-value
Constant						7.20	64.40
Income	16,984	17,850	18,761	19,718	20,724	0.01	4.26
High school	0.352	0.345	0.339	0.332	0.326	0.64	8.31
Some college	0.241	0.248	0.255	0.263	0.270	0.97	10.97
College	0.235	0.242	0.249	0.257	0.264	1.44	15.49
No high school	0.173	0.165	0.157	0.148	0.140		
Age 20-35	0.325	0.313	0.303	0.297	0.287	0.42	4.28
Age 36-50	0.301	0.290	0.274	0.257	0.245	0.56	5.79
Age 51-65	0.207	0.233	0.252	0.259	0.255	0.45	5.37
Age 66 and over	0.161	0.164	0.171	0.187	0.213		
Midwest	0.290	0.223	0.219	0.214	0.211	0.12	1.43
South	0.356	0.358	0.360	0.361	0.363	0.07	0.84
West	0.225	0.231	0.237	0.244	0.252	-0.19	2.11
Northeast	0.190	0.188	0.184	0.181	0.174		
Nonmetro	0.179	0.171	0.164	0.158	0.151	-0.10	1.31
Suburb	0.493	0.504	0.514	0.523	0.532	-0.06	0.82
City	0.328	0.325	0.322	0.319	0.317		
Black	0.124	0.125	0.127	0.128	0.129	-0.40	4.34
White	0.704	0.683	0.662	0.643	0.625		
Hispanics	0.126	0.141	0.155	0.167	0.180	-0.62	5.68
Asian	0.039	0.044	0.049	0.053	0.058	-0.68	3.10
Other race	0.007	0.007	0.007	0.009	0.008	-0.24	0.98
HH type1	0.235	0.218	0.198	0.183	0.167	0.37	4.62
HH type2	0.281	0.290	0.297	0.306	0.314	0.28	4.03
HH type3	0.092	0.091	0.090	0.089	0.087	0.17	1.14
Dietary knowledge	8.166	8.170	8.169	8.167	8.162	R^2 = 0.15, N = 5648	

Notes: See table 2 for the unit of measurement. See Lin et al for derivations of the forecasts.

Figure 1. Changes in per capita pork consumption in the U.S.

(base year 2000 = 100)

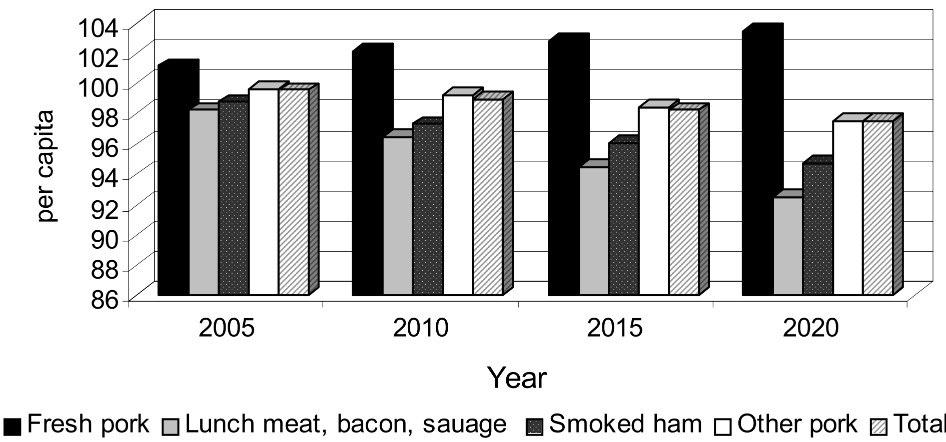

Figure 2. Growth in U.S. total pork consumption by cuts

(base year 2000 = 100)