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Consumption of Pork Products: Now and to the Year 2020

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Data from the U.S. Department of Agriculture's 1994–96 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) 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 for adults, using a maximum-likelihood procedure. The estimated system is used to predict consumption of pork products by adults through the year 2020.

Key Words: censored dependent variables, CSFII, pork consumption, Tobit system

Pork, "the other white meat," is one of the most desired meats in the United States. In 2002, pork accounted for 40% of all red meats consumed [U.S. Department of 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, little or no data are available 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).

In this study, we 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,

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and the estimated system was used to forecast consumption of pork products through the year 2020. The descriptive analysis covered all U.S. consumers, but the demand system and forecast were implemented for adults only.

Data

The USDA has conducted periodic food consumption surveys in the United States since the 1930s. 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 companion 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 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 expand 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 nine years of age. The CSFII respondents 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 of age or older) 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 by CSFII respondents. 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. Because we were interested in examining the role of dietary knowledge in pork consumption, 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 data 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 lunch meats, hot dogs, bacon, sausage, smoked ham, and other processed pork. Due to space limitations, table 1 describes pork consumption in terms of percentage of market distribution, and per capita consumption in pounds (with values for pounds given in parentheses) for the two aggregated product forms—fresh and processed.

CSFII data indicate that 38% and 62% (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%) and considered as at-home food. A larger proportion of fresh pork was purchased for at-home consumption (82%), compared with the 76% for processed pork. Restaurants, including fast food places, represented the bulk of pork consumed away from home, with a 17% share of total pork consumption (11 pounds per person per year). CSFII respondents consumed an average of 7 pounds of processed pork and 4 pounds of fresh pork at restaurants during 1994–98.

As observed from table 1, 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, representing 24% of the U.S. population, accounted for 27%, 27%, and 27% of fresh, processed, and total pork consumption, respectively. Both fresh and processed pork were favored in the Midwest. Pork was favored by rural consumers, who represented 21% of the U.S. population and accounted for 25% 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.

Table 1. U.S. Consumption of Fresh and Processed Pork: Market Distribution and Per Capita (1994–1998)

Item	Population Share	Market Share, % / (Per Capita Consumption, Pounds)					
		All Pork		Fresh Market		Processed Market	
Consumption – 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)
Other		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)
Metro. Statistical Area (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 Race	4.4	4.9	(73.7)	10.3	(49.2)	2.4	(24.5)
Household Income as a % of Poverty:							
Under 130%	19.2	20.2	(69.6)	21.4	(23.4)	19.7	(46.2)
131–350%	41.8	43.1	(68.1)	41.6	(20.9)	43.8	(47.2)
Over 350%	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, 20–39	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, 20–39	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: Continuing Survey of Food Intakes by Individuals, 1994–96 and 1998 (USDA, Agricultural Research Service, 2000).

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% 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% of the U.S. population, respectively. The 2000 Census results reveal 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 pounds consumed by other races, 64 pounds by Whites, and 57 pounds by Hispanics. 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 by-products); brunch meats (includes lunch meats, hot dogs, bacon, and sausage); smoked ham; and other pork. Based on the CSFII data, over the two-day survey period, 23%, 35%, 21%, and 38% of the DHKS respondents consumed fresh pork, brunch meats, 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, 1974). Following Amemiya, to accommodate such censoring, we used a censored multi-equation system procedure. Using a vector $\mathbf{x}$ to represent explanatory variables, a linear functional form to approximate each deterministic demand function, and a random error γ_i to capture the unobservables, we consider a system of censored equations such that:

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

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 R goods are consumed, with observed n-vector $[\mathbf{q}_1, ..., \mathbf{q}_R, \mathbf{0}, ..., \mathbf{0}]'$. Denote the random error vector as $\xi = [\xi_1', \xi_2']'$, partitioned such that $\xi_1 = [\gamma_1, ..., \gamma_R]'$ and $\xi_2 = [\gamma_{R+1}, ..., \gamma_n]'$, and assume ξ is distributed as n-variate normal with zero mean and $n \times n$ covariance matrix $\boldsymbol{\Sigma} = [\rho_{ij}\sigma_i\sigma_j]$, where ρ_{ij} are the

error correlation coefficients and σ_i are the error standard deviations. Denote $\mathbf{u} = [-\mathbf{x}'\beta_{R-1}, -\mathbf{x}'\beta_{R-2}, ..., -\mathbf{x}'\beta_n]'$. Then, the censoring mechanism (1) implies the regime-switching condition,

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

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

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

where $\xi_1 = [q_i - \mathbf{x}'\boldsymbol{\beta}_i]$ is an R-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, 2000). The sample likelihood function is the product of the likelihood contributions (2) over the sample units. The unknown parameters are β_i; σ_i ($i = 1, 2, ..., n$); and ρ_{ij} for $i > j$.

Estimation Results

Maximum-likelihood estimation was carried out by programming the log-likelihood function in GAUSS. Normal probability integrals up to dimension three were evaluated with a numerical procedure (Kotz, Johnson, and Balalrishnan, 2000, pp. 121–145), and for 26% of the sample (or 1,488 individuals), four-level probability integrals were evaluated with a smooth probability simulator known as the GHK simulator (Hajivassiliou, 1994).

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 specified as follows (McDonald and Moffitt, 1980):

$$E(q_i) = \Phi(\mathbf{x}'\boldsymbol{\beta}_i / \sigma_i)\mathbf{x}'\boldsymbol{\beta}_i + \sigma_i \phi(\mathbf{x}'\boldsymbol{\beta}_i / \sigma_i), \tag{3}$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the univariate standard normal probability density function and the cumulative distribution function, respectively. 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, 1999).

The explanatory variables in the demand system included household income, dietary knowledge, household size, household type, age, gender, education, race/ethnicity, employment status, and seasonal/location dummy variables. The variable names and definitions and descriptive statistics of the sample are given in table 2.

Table 2. Variables, Definitions, and Descriptive Statistics for the Censored Demand System

Variable	Definition	Mean	Std. Dev.
Fresh Pork	Pork chops, loin, rib, ham, and other fresh cuts, excluding offal or by-products (grams/day)	4.61	12.54
Brunch Meat	Lunch meat, hot dogs, 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
Dietary Knowledge	Scores of dietary knowledge (0−12)	8.14	2.20
Income	Household income, per capita ($000s)	16.02	13.70
Household Size	Number of household members	2.59	1.46
High School	Respondent completed high school education but did not go to college (0, 1)	0.27	0.44
Some College	Respondent attended college but did not receive a degree (0, 1)	0.31	0.46
College	Respondent completed a college degree (0, 1) [base = *No High School*]	0.22	0.41
Male	Respondent is male (0, 1)	0.50	
Employment Status	Respondent is employed (0, 1)	0.57	
Age 20−35	Age of respondent is 20 to 35 (0, 1)	0.23	
Age 36−50	Age of respondent is 36 to 50 (0, 1)	0.27	
Age 51−65	Age of respondent is 51 to 65 (0, 1) [base = *Age 66 and over*]	0.27	
Black	Respondent is non-Hispanic Black (0, 1) [base = *Non-Hispanic White*]	0.11	
Hispanic	Respondent is Hispanic (0, 1)	0.08	
Asian	Respondent is Asian, Pacific Islander (0, 1)	0.02	
Other Race	Respondent's race/ethnicity is none of the above, and is not White (0, 1)	0.01	
Household Type 1	Household is dual-headed, with children (0, 1)	0.28	
Household Type 2	Household is dual-headed, without children (0, 1)	0.36	
Household Type 3	Household is single-headed (either male or female), with children (0, 1)	0.04	
Midwest	Respondent resides in the Midwestern region (0, 1)	0.25	
South	Respondent resides in the Southern region (0, 1)	0.35	
West	Respondent resides in the Western region (0, 1) [base = *Northeast* region]	0.20	
Non-Metro	Respondent resides in rural area (0, 1)	0.27	
Suburb	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 falls in April–June (0, 1)	0.26	
Quarter 3	The first day of intake falls in July–September (0, 1) [base = *Quarter 4*]	0.28	

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 from 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 score 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, as well as their standard errors and significance levels, are reported in table 3. The censored demand results suggest that household income had a significant and negative effect on per capita consumption of brunch meats (i.e., lunch meats, 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 by Lin et al. (2003, tables 15 and 16), whose study applied a different approach to the same data.

Pork consumption was found to be quite stable across the four seasons of the year (table 3). Males consumed more pork than did females. Seniors (those age 66 and older) consumed less pork compared to 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. Individuals 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. Blacks preferred consuming fresh pork, brunch meats, and other pork. Whites consumed more smoked ham than did other consumers, while Hispanics favored 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 use of CSFII and DHKS data limited our analysis to adults because DHKS data were collected for adults only. 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 selected variables, in five-year increments beginning with the year 2000, are reported in table 4. Values of other exogenous variables not included 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. (2003).

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

	Fresh Pork		Brunch Meat[a]		Smoked Ham		Other Pork	
Variable	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)
Dietary 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)
Age 20–35	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)
Age 36–50	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)
Age 51!65	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)

(continued . . .)

Table 3. Continued

Variable	Fresh Pork		Brunch Meat[a]		Smoked Ham		Other Pork	
	Estimate	Elasticity	Estimate	Elasticity	Estimate	Elasticity	Estimate	Elasticity
Binary Variables (cont.):								
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 Race	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 Type 1	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)
Household Type 2	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)
Household Type 3	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)
Employment 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)
Sigma (σ)	75.14		33.86		68.29		21.80	
	(1.54)		(0.27)		(1.23)		(0.15)	
Log Likelihood = !39,965.77								

Notes: Single, double, and triple asterisks (*) denote statistical significance at the 10%, 5%, and 1% levels, respectively. Numbers in parentheses are standard errors.
[a] Brunch meat includes lunch meats, hot dogs, bacon, and sausage.

Table 4. Projected Economic, Knowledge, Social, and Demographic Variables, 2000–2020

						Fitted Dietary Knowledge	
Exogenous Variables[a]	2000	2005	2010	2015	2020	Coeffic.	*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	[base group]	
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 65 and over	0.161	0.164	0.171	0.187	0.213	[base group]	
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	[base group]	
Non-Metro	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
Central City	0.328	0.325	0.322	0.319	0.317	[base group]	
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	[base group]	
Hispanic	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
Household Type 1	0.235	0.218	0.198	0.183	0.167	0.37	4.62
Household Type 2	0.281	0.290	0.297	0.306	0.314	0.28	4.03
Household Type 3	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		
$R^2 = 0.15$, $N = 5{,}648$							

Note: See Lin et al. (2003) for derivations of the forecasts.

[a] Refer to table 2 for definitions and units of measurement.

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 rises with income and educational achievement, but declines with age. Dietary knowledge also varies 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. Consequently, 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 respective 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 is predicted to rise by 3.4% between 2000 and 2020, whereas per capita consumption of brunch meat, smoked ham, and other pork are predicted to fall by 7.5%, 5.2%, and 2.5%, respectively, during the 2000–2020 period.

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 is predicted that those older than 65 will increase their share of the U.S. population over the 2000–2020 period, and this age group (the base group in our regression) was found by the CSFII to consume the least amount of all four pork cuts (Lin et al., 2003). Hispanics, Asians, and Blacks are expected to increase their representation in the U.S. population. Based on CSFII data, 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 the 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 will age to the extent that those older than 65 are predicted to increase their representation at the expense of each of the other three age groups, i.e., ages 20–35, 36–50, and 51–65.

Because of the rising U.S. population, total U.S. consumption of all four pork cuts is expected to increase between 2000 and 2020. Among the four cuts, only fresh pork is predicted to exhibit increasing per capita consumption. Therefore, total fresh pork consumption is estimated to rise at a faster rate (22% over 20 years) than the other cuts (9% for brunch meats, 12% for smoked ham, and 15% for other pork). Combining the four cuts, total U.S. pork consumption is predicted to rise by 15% 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., 2003). 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 these factors also indirectly affect pork consumption through dietary knowledge. The decomposition analysis was not conducted for this study.

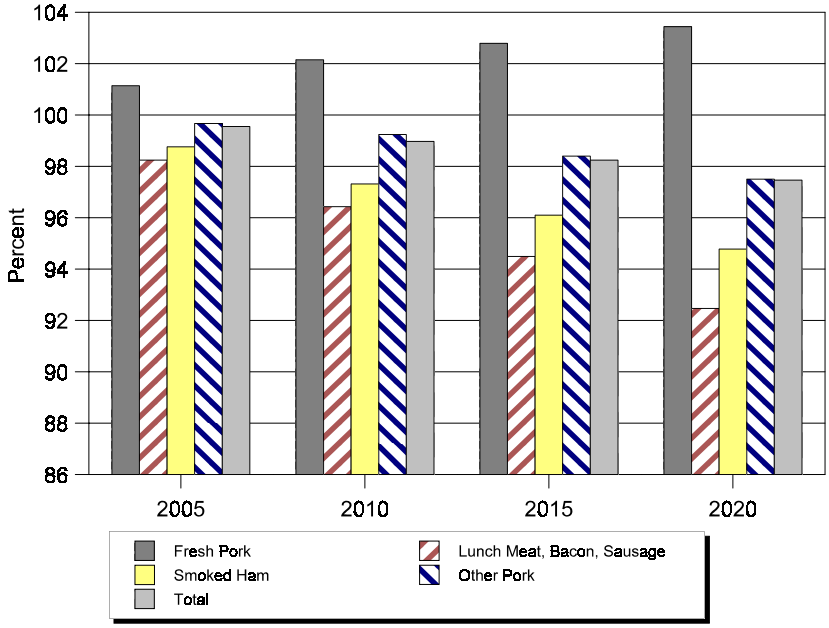

Figure 1. Changes in per capita pork consumption in the U.S. (base year 2000 = 100)

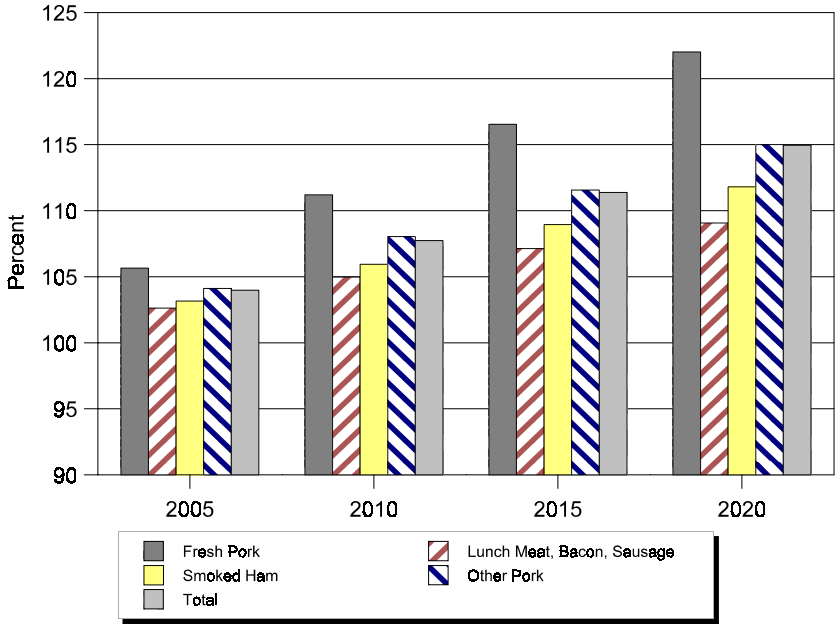

Figure 2. Growth in U.S. total pork consumption by cut (base year 2000 = 100)

Conclusions

Data from the USDA's Continuing Survey of Food Intakes by Individuals (CSFII) 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 descriptive analysis was carried out for total U.S. pork consumption, whereas the demand estimation and forecast were conducted for adults only. The data show that the processed market dominated the fresh market (68% versus 32%), and the at-home market dominated the away-from-home market (78% versus 22%). Our analysis reveals 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 the future pork market.

The estimated demand system for pork cuts and the predicted social, economic, and demographic conditions were used to predict per capita consumption of the pork cuts. The results suggest per capita consumption of fresh pork will rise but the consumption of processed pork will decline over the next two decades. However, the U.S. population is predicted to grow by an estimated 50 million people. Consequently, between 2000 and 2020, the consumption of fresh pork is predicted to increase by 22%, followed by a 15% growth in other pork, 12% for smoked ham, and 9% for lunch meats, hot dogs, bacon, and sausage.

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