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A quantitative analysis of the demand for pork in the United States (1966-1996)

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**A Quantitative Analysis of the Demand for Pork
in the United States (1966-1996)**

**A THESIS
Presented to the**

**Honors College at Southern University
Baton Rouge, Louisiana**

**In Partial Fulfillment of the Requirements for the
Honors College Degree**

by

**Raven Nicole Matthews-Pillette
December 1998**

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HONORS THESIS

This is to certify that the Honors Thesis of
Raven Nicole Matthews-Pillette
has been approved by the examining committee for the thesis requirement
for the Honors College degree in Agricultural Economics.

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**A Quantitative Analysis of the Demand for Pork
in the United States (1966-1996)**

An Abstract of a Thesis

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ABSTRACT

The following study examines the trend in the demand for pork over the years from 1966 to 1996. The effect of pork price is used to quantitatively determine own-price influence in pork demand. The price of beef and chicken are used to measure the effects of these known substitutes on the demand for pork. Bread price is used as a complementary influence on pork demand. Finally, income and tastes and preferences are used to quantitatively measure their respective influence on the consumption of pork meat. Results showed that out of the prices of pork, beef, chicken, and bread; income; and preferences, only pork prices and preferences statistically significantly influence pork demand. Collectively, all of the aforementioned variables influence pork demand. Further, log-linear regression analysis reveals demand elasticities inconsistent with theory because of strong preferences.

Pointedly calculated elasticities reveal that:

- ◆ consumers barely respond to pork price changes,
- ◆ beef and chicken are not clear substitutes, and
- ◆ pork is a normal good.

Producers would benefit by advertising possible health benefits of eating pork.

Key words: pork, beef, demand, consumption

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CHAPTER I INTRODUCTION/OVERVIEW

As an expected component of any meal for the general population, meat deserves the devotion of researchers seeking to discover what factors influence its demand. Pork, the object of this study, has faced competition from beef, poultry (turkey and chicken), and fish for consumers' choice of meat. On the supply side, the entire hog industry has experienced some difficulties due to skyrocketing wholesale-to-retail margins as a result of the industry's changing structure. The emergence of "discount warehouse stores" and the share of retailers' profit have added to the industry's woes. Still, it can be inferred that consumers are not affected solely by cheaper pork prices. This study examines how factors such as own-price, price of related goods, income, tastes and preferences, population, seasonality, and price expectations influence the demand for pork.

Over the last few decades, pork consumption patterns have changed considerably relative to the consumption of other meat products. Generally, consumers have allowed pork prices, prices of other meats, prices of rice and potatoes, income, and tastes and preferences to guide their consumption of pork. In light of the almost doubled consumption of chicken during the last two decades, pork consumption, used in this paper as the estimate of the demand for pork, has seen a downward trend due to the aforementioned negative effects reverberating from the hog industry. Despite production problems, retail demand is still an indicator of consumers' demand for pork. Regression techniques are used to determine the magnitude of the influence of pork prices, other meat prices, bread prices, income, and tastes and preferences on the demand for pork individually and collectively.

CHAPTER II LITERATURE REVIEW

Numerous studies focusing on both supply and demand issues in pork consumption have been published and are in the creation process. This literature review explores studies concentrating on supply of pork and the welfare of the hog industry, particularly the happenings causing the large wholesale-to-retail margin. Special attention also is paid to studies that examined the demand for pork.

In his 1993 study titled, "Distribution of Gains from Research and Promotion in Multi-Stage Production Systems: The Case of the U.S. Beef and Pork Industries," Wohlgenant recognizes that "little attention has been given to evaluating returns from promotion" in the beef and pork industry (p.642). Comparatively, much attention has been given to exploring the effects of research on this industry, though concentration on the former would generate exploration of the structural change in a consumer's demand curve. Wohlgenant goes further declared that "the lion's share of the check-off funds goes for promotion," (p. 650). He advanced the idea that the demand for beef and pork and the input supply curves should be studied further(1993). Stoddart, in his research of the countervailing duty on pork, defined the retail demand for pork as "a function of own price, prices of substitutes, and the level of personal income" (1991, p. 1564). Stoddart used regression techniques and a price dependent demand curve because he felt price, rather than quantity adjusted more readily to clear the market (Stoddart 1991). Stoddart's empirical results confirmed his *a priori* assumptions. A negative relationship was found between pork price and quantity relationships and a positive relationship between pork price and beef price. The latter normally occurs with close substitutes (Stoddart 1991).

Previous studies suggest that generic advertising and health information, when examined in isolation, do indeed influence meat consumption patterns (Ward and Lambert; Capps and Schmitz; McGuirk et al.). Kinnucan, Xia, Hsia, and Jackson studied the affects of health information and generic advertising on U.S. meat consumption patterns (1997). When generated from annual data, estimates for advertising tend to be biased upward. Nevertheless, Kinnucan, et al. hypothesized that the actual trend for consumer tastes and preferences was negative. As in the previous study, many other studies have analyzed structural changes in meat demand (Brester and Schroeder; Alston, Chalfant, and Piggott; Huang; Thurman; and Waugh.). Because of different methodologies and data usage, the results have been varied. However, there is a general consensus that pork demand has changed structurally due to various factors in addition to price, price of related goods, income, and tastes and preferences. Hard evidence on whether consumer preferences have changed has remained elusive. Capps and Schmitz, by comparison, found that poultry experienced increases in consumption at the expense of pork. Guided by the knowledge from previous research, my study contributes to the knowledge of the individual and collective influence of factors on pork demand over the past three decades.

CHAPTER III OBJECTIVES

The goal of this paper is to examine the factors that influence the demand for pork.

The Specific Objectives are:

1. To determine the individual influence and the collective influence of the price of pork, price of beef, chicken, and bread, disposable income, and tastes and preferences on the demand for pork;
2. To calculate the own-price, cross-price, and income elasticities of demand for pork; and
3. To propose methods for pork producers to increase consumer demand for pork.

CHAPTER IV CONCEPTUAL FRAMEWORK

Demand is defined by Spencer and Amos as “the amounts of a commodity that buyers would be willing and able to purchase at various prices during a given period time, all other things remaining the same” (p. 562). When examining the demand for pork in relation to factors influencing demand several basic concepts arise. First, several factors are said to influence or either cause demand to change or the quantity demanded to change (i.e. movement along the demand curve).

In this study, quantity demanded (Q_d) is expressed as a function of the price of pork (P_p), the price of beef (P_b), the price of chicken (P_c), the price of bread (P_{br}), income (I), and tastes and preferences (t). This function is expressed mathematically as:

$$1. \quad Q_d = f(P_p, P_b, P_c, P_{br}, I, t)$$

where

Q_d = Per capita consumption of pork

P_p = Real prices of pork

P_b = Real prices of beef

P_c = Real prices of chicken

P_{br} = Real prices of bread

I = Real disposable per capita incomes

t = Time (i.e. used here as a proxy for tastes and preferences)

Furthermore, each of these variables is evaluated for their influence on the demand for pork.

Four economic concepts serve as the basis for evaluating the influence of these variables on the demand for pork. First, the nature of substitutes necessitates that the price of the commodity exhibits a direct relationship with the quantity demanded for pork; that is, an increase in the price of the substitute causes the quantity demanded of pork to increase. *A priori*, such is the case for the prices of beef and chicken. Conversely, the nature of complements dictates that the price of the commodity exhibits an inverse relationship with the quantity demanded of pork; that is, an increase in the price of the complement causes the quantity demanded of pork to decrease, which is the *a priori* assumption for bread prices. Third, consumption of normal goods tends to increase with corresponding increases in income (Tomek and Robinson, 1990). Consequently, a priori expectation is a positive relation between income and quantity demanded of pork. Finally, using information on tastes and preferences for pork, it can be seen that pork popularity has fluctuated over the years in response to health information and advertising. These relationships can be used to formulate a basic a priori linear demand function for pork as:

$$2. \quad Q_d = \beta_0 - \beta_1 P_p + \beta_2 P_b + \beta_3 P_c - \beta_4 P_{br} + \beta_5 I + \beta_6 t + \epsilon_t$$

All variables are as previously defined; “ ϵ_t ” is the random stochastic error term. Equation 2 can be used to analyze the influence (combined) of the explanatory variables on the quantity demanded of pork.

A second model, the log-linear demand function for pork, is used to evaluate the elasticities of demand for pork. Theoretically, the own-price, cross price with beef and chicken, cross price with bread, and income elasticities are expected to have negative, positive, negative, and positive signs, respectively. Each sign's direction is primarily determined by the basic definition of elasticity, which is a measure of the responsiveness of quantity demanded to changes in prices or income (Tomek and Robinson, 1990). The log-linear model is written mathematically as:

$$3. \quad \ln Q_d = \ln \beta_0 - \ln \beta_1 P_p + \ln \beta_2 P_b + \ln \beta_3 P_c - \ln \beta_4 P_{br} + \ln \beta_5 I + \beta_6 t + \epsilon_t$$

In this model, the β 's are regression coefficients, and β_1 through β_5 are elasticity coefficients. The latter are used to classify the demand for pork. *A priori*, the demand for pork is inelastic, because, on average, U.S. consumers spend a relatively small percentage of their incomes buying pork.

CHAPTER V METHODS AND PROCEDURES

To more fully analyze the present situation of the pork industry, it is necessary to gain knowledge of past trends experienced by the market. Both statistical techniques and hypothesis testing will be used to evaluate data. The data for this study were collected from U.S. Departments of Agriculture and Commerce's publications, from scientific journal articles, and from popular magazines. The data set containing nominal prices and incomes, per capita consumption of pork, and U.S. population is shown in table 1. Price and income data in table 1 were deflated so that the regression could be run using real prices and incomes (i.e. those adjusted for inflation). Deflating the data involved dividing the nominal price by the consumer price index, 1982-84 as base year, for that year then multiplying by 100. The deflated data are shown below in table 2. Each of the variables' data reflect consistency. The quantity demanded of pork and income are both expressed per person in the United States. Additionally, the prices are all expressed in dollars per pound of pork, beef, chicken, and bread. This data set was used to run multiple regression analyses using *Absurv's* statistical software. The quantity demanded of pork was expressed as the dependent variable with prices of pork, beef, chicken, and bread; income; and tastes and preferences as independent variables. The regression results from both models allow the testing of the collective influences of these variables on the demand for pork. Individual influence of the independent variables on pork demand also can be tested from the regression results.

Additionally, the log-linear model yields estimates for own-price, cross-price, and income elasticities of demand.

**Table 1: Per Capita Consumption, Nominal Prices and Incomes, Population from
1966-1996**

Year	Qd Pork	Pork	Beef	Chicken	Bread	Income	Population	T and P
		Price	Price	Price	Price			
	per capita in lbs.		in dollars per lb.			Total in billions	total in thousands	
1966	54.4	0.73	0.84	0.40	0.25	533.7	196560	1
1967	60.0	0.67	0.85	0.37	0.26	571.9	198712	2
1968	61.4	0.67	0.89	0.38	0.26	621.4	200706	3
1969	60.5	0.74	0.90	0.41	0.27	668.4	202677	4
1970	55.2	0.77	1.02	0.40	0.28	727.1	205052	5
1971	60.2	0.70	1.08	0.42	0.29	790.2	207661	6
1972	54.3	0.83	1.19	0.41	0.28	855.3	209896	7
1973	48.5	1.09	1.42	0.60	0.32	965	211909	8
1974	52.4	1.08	1.46	0.56	0.39	1054.2	213554	9
1975	43.1	1.35	1.55	0.63	0.41	1159.2	215973	10
1976	44.7	1.34	1.48	0.60	0.40	1273	218035	11
1977	46.7	1.25	1.48	0.60	0.41	1401.4	220239	12
1978	46.5	1.44	1.52	0.67	0.42	1580.1	222585	13
1979	53.2	1.44	2.26	0.68	0.47	1769.5	225055	14
1980	56.8	1.39	2.34	0.71	0.51	1973.3	227726	15
1981	54.2	1.52	2.35	0.73	0.53	2200.2	229966	16
1982	48.6	1.75	2.38	0.71	0.53	2347.3	232188	17
1983	51.3	1.70	2.34	0.73	0.54	2522.4	234307	18
1984	51.0	1.62	2.36	0.81	0.54	2810	236348	19
1985	57.5	1.62	2.29	0.76	0.55	3002.2	238466	20
1986	48.6	1.78	2.27	0.84	0.57	3187.6	240651	21
1987	48.8	1.88	2.38	0.79	0.55	3363.1	242804	22
1988	52.1	1.83	2.50	0.85	0.61	3640.8	245021	23
1989	51.5	1.83	2.66	0.93	0.67	3894.5	247342	24
1990	49.4	2.13	2.81	0.90	0.70	4166.8	249913	25
1991	50.0	2.12	2.88	0.88	0.71	4343.7	252650	26
1992	52.7	1.98	2.85	0.87	0.75	4613.7	255419	27
1993	52.1	1.98	2.93	0.89	0.75	4789.3	258137	28
1994	52.7	1.98	2.83	0.90	0.76	5018.8	260660	29
1995	52.4	1.95	2.84	0.92	0.79	5320.8	263034	30
1996	53.0	2.21	2.80	0.97	0.88	5588.5	264037	31

Sources: H. Elitzak *Food Cost Review, 1996*; *Food Cost Review, 1995*; J.J. Putnam and J.E. Allshouse *Food Consumption, Prices, and Expenditures, 1996*; U.S. Dept. of Commerce, *Statistical Abstract of the U.S., 1996*.

Table 2: Data with Deflated Prices and Incomes

	Qd Pork	Pork	Beef	Chicken	Bread	Income	T and P
	Price	Price	Price	Price	Price		
	per capita	in dollars per lb.				per capita	
	in lbs.	1982-84=100				in dollars	
1966	54.4	2.26	2.60	1.20	0.77	8354	1
1967	60.0	1.99	2.53	1.06	0.78	8617	2
1968	61.4	1.92	2.55	1.04	0.75	8897	3
1969	60.5	2.01	2.44	1.06	0.74	8986	4
1970	55.2	1.99	2.62	0.99	0.72	9139	5
1971	60.2	1.72	2.67	1.00	0.72	9396	6
1972	54.3	1.98	2.84	0.92	0.67	9749	7
1973	48.5	2.46	3.20	1.22	0.72	10256	8
1974	52.4	2.19	2.96	1.04	0.79	10013	9
1975	43.1	2.50	2.88	1.11	0.76	9976	10
1976	44.7	2.36	2.60	0.99	0.70	10261	11
1977	46.7	2.07	2.44	0.92	0.68	10500	12
1978	46.5	2.20	2.33	0.92	0.64	10888	13
1979	53.2	1.98	3.11	0.83	0.65	10830	14
1980	56.8	1.69	2.84	0.78	0.62	10516	15
1981	54.2	1.68	2.59	0.76	0.58	10525	16
1982	48.6	1.82	2.47	0.71	0.55	10476	17
1983	51.3	1.70	2.35	0.70	0.54	10809	18
1984	51.0	1.56	2.27	0.75	0.52	11443	19
1985	57.5	1.51	2.12	0.69	0.51	11700	20
1986	48.6	1.63	2.07	0.74	0.52	12086	21
1987	48.8	1.66	2.10	0.67	0.48	12193	22
1988	52.1	1.55	2.12	0.69	0.52	12561	23
1989	51.5	1.48	2.14	0.71	0.54	12698	24
1990	49.4	1.63	2.15	0.66	0.54	12757	25
1991	50.0	1.56	2.12	0.63	0.52	12623	26
1992	52.7	1.41	2.03	0.62	0.53	12866	27
1993	52.1	1.40	2.08	0.62	0.53	13168	28
1994	52.7	1.37	1.96	0.61	0.53	13343	29
1995	52.4	1.31	1.92	0.60	0.53	13631	30
1996	53.0	1.44	1.83	0.63	0.57	13807	31

Sources: H. Elitzak *Food Cost Review, 1996*; *Food Cost Review, 1995*; J.J. Putnam and J.E. Allshouse *Food Consumption, Prices, and Expenditures, 1996*; U.S. Dept. of Commerce, *Statistical Abstract of the U.S., 1996*.

**CHAPTER VI
EMPIRICAL RESULTS**

Table 3: Linear Regression Results

Variables	Regression	Standard	T	Prob	Mean
	Coefficients	Error			
Constant	72.5684	1.83428			
P _p	-22.8248***	2.53152	-9.01622	0.0000	1.8074
P _b	1.9780	1.62780	1.21514	0.2361	2.4177
P _c	2.7637	8.88812	0.31094	0.7585	0.8345
P _{br}	24.4078**	9.75467	2.50217	0.0196	0.6200
l	0.0008	0.00152	0.51116	0.6139	11067
t	-0.6113*	0.34192	-1.78796	0.0864	16

Other stats:

F test = 26.6866***

F test Prob = .0000

R square = .86965

Adj. R square = .837063

Standard Error of Estimate = 1.83428
1.83428

The *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively.

Variables	Elasticities (Regr. Coeff)	Stand Coeff	Stand Error	T	Prob
Constant term	2.50051				
LnP _p	-0.77776***	-1.63782	0.09642	-8.06632	0.0000
LnP _b	0.07460	0.12762	0.08342	0.89426	0.3801
LnP _c	-0.14831	-0.38365	0.17306	-0.85696	0.3999
LnP _{br}	0.31329**	0.57925	0.12277	2.55188	0.0175
LnI	0.23998	0.40033	0.33236	0.72205	0.4772
t	0.01700**	-1.78279	0.00715	-2.37771	0.0257

Other stats:

F test = 24.7062***

F test Prob = .0000

R square =

.860657

Adj. R square = .825821

Standard Error of Estimate = .0361849

The *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively.

Table 3, above, shows the empirical results to the linear model. The results suggest that this model is representative of the market for pork. Determination of this can be made based on the coefficients of determination or R^2 for each model. The value of the r-squared for the linear model is 0.87. These values can be interpreted as roughly 87 percent of the variation in the demand for pork can be explained by the prices of pork, beef, chicken, bread, by income, and by tastes and preferences. The results have several implications on the *a priori* assumptions. First, the inverse relationship between price of pork and quantity demanded is verified. Second, the direct relationships between prices of beef and chicken -- indicated as substitutes -- is also verified. Third and unexpectedly, there is also a direct relationship between quantity demanded and the price of bread, which was hypothesized as a complement. Fourth, the negative sign in front of the income variable disproves my assumption that pork is a normal good. Finally, the negative sign before tastes and preferences dictates a decline in consumer preference for pork.

Examination of the F-test reveals that the variables possess a highly statistically significant influence on pork demand. The t-tests for the influence of each individual variable show that only the price of pork is significant at the 0.01 level. At the 0.05 level the price of bread is significant which implies that bread has a role as a strong substitute for pork in American society. Finally, at the 0.10 level, tastes and preferences are statistically significant.

Results for the log-linear model are presented in table 4. The value of the R^2 for this model is 0.86, suggesting that 86 percent of the variation in " $\text{Ln}Q_d$ " is explained by the six

variables. Two of the six regression coefficients statistically significantly influence pork demand. The negative, statistically significant coefficient for " LnP_p " suggests that pork has an inelastic demand. The positive, statistically insignificant coefficients for " LnP_b " and " LnP_{br} " suggest that beef and bread are substitutes for pork. The negative, statistically significant, at the 10 and 5 percent levels, coefficient for " LnP_c " indicate that chicken is a complement for pork. The positive, statistically insignificant coefficient for " LnI " suggests that pork is a normal good and a necessity. Finally, the negative, statistically significant, at the 10 and 5 percent levels, coefficient for " t " suggests that tastes and preferences have declined overall in the past thirty years.

Furthermore, when testing at the 0.05 level of significance, the elasticities given in the demand equation can be either refuted or accepted when performing t-test and f-tests. A test on the own price of elasticity value's classification as inelastic supports the regression's figure. Next, a test on the cross-price elasticity of beef with pork reveals that beef is a complement of pork. Third, a test on the cross-price elasticity of beef with chicken reveals that the model is wrong and that chicken is a substitute for pork. Fourth, a test on the cross price elasticity reveals that bread is a statistically significant substitute for pork. Finally, a test on the income elasticity of demand reveals that pork is indeed a necessity. The f-test reveals that this model has a highly statistically significant influence on pork demand.

To attain that final goal of proposing methods for pork producers to increase consumer demand for pork, there are several suggestions after reviewing the data. The

primary suggestion would be to control prices by regulating production since price and tastes and preferences both maintain statistically significant influence on the demand for pork. Regarding tastes and preferences, consumer should continue to downplay the negative health aspects associated with eating pork.

CHAPTER VII SUMMARY AND CONCLUSIONS

The study's general objectives were to (1) determine the individual and collective influences of the price of pork, prices of beef, chicken, and bread, income and tastes and preferences on the quantity demanded of pork; (2) calculate the own-price, cross-price and income elasticities of demand for pork; and (3) propose methods for pork producers to increase consumer demand for pork. The findings imply that pork demand was statistically significantly influenced by pork price, bread price, and tastes and preferences; that pork has an inelastic demand; and that pork and bread were substitutes. Although not statistically significant, the model proposed that beef was a substitute for pork, and chicken a complement. Pork was classified as a necessity, based on the income elasticity coefficient. For both models, tastes and preferences influenced pork consumption. Additional hypothesis testing of the elasticities revealed that the demand is inelastic, the cross-price elasticities with chicken and beef are not statistically supported by the model. Finally, pork producers would benefit by concentrating on prevention of drastic price increases and by advertising the benefits of pork consumption relative to other meats.

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Raven Nicole Matthews Pillette is a natural-born citizen of the United States. She was born on November 3, 1977, in Lafayette, Louisiana to Mr. Howard T. Matthews, Sr. and Mrs. Brenda Willis Matthews both of Abbeville, Louisiana. Raven is the second child of four and is the oldest girl in her family. Raven is a 1995 graduate of Abbeville High School, where she was salutatorian. Upon application to Southern University, Raven received a full scholarship from the Southern University Honors College and was named a 1995 U.S. Department of Agriculture 1890 Scholar, which gave her internships, a computer, books, tuition, and a job upon graduation. In the course of her matriculation, Raven married Louis Keith Pillette with whom she has a beautiful thirteen-month baby girl. Now, in this fall semester of 1998 Raven is preparing for graduation with a bachelor of science in agricultural economics and the added honor of the Honors College stamp with the completion of the Honors College requirements.

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Author Ross Matthew Pillemer

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