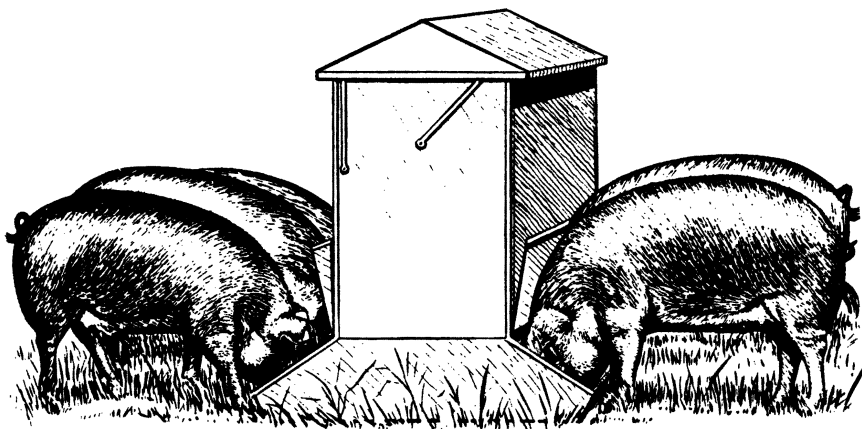


**An Econometric Import Demand  
and Market Analysis:  
The Case of Pork in Mexico**



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**Oklahoma Agricultural Experiment Station  
Division of Agricultural Sciences and  
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# **An Econometric Import Demand and Market Analysis: The Case of Pork in Mexico**

By

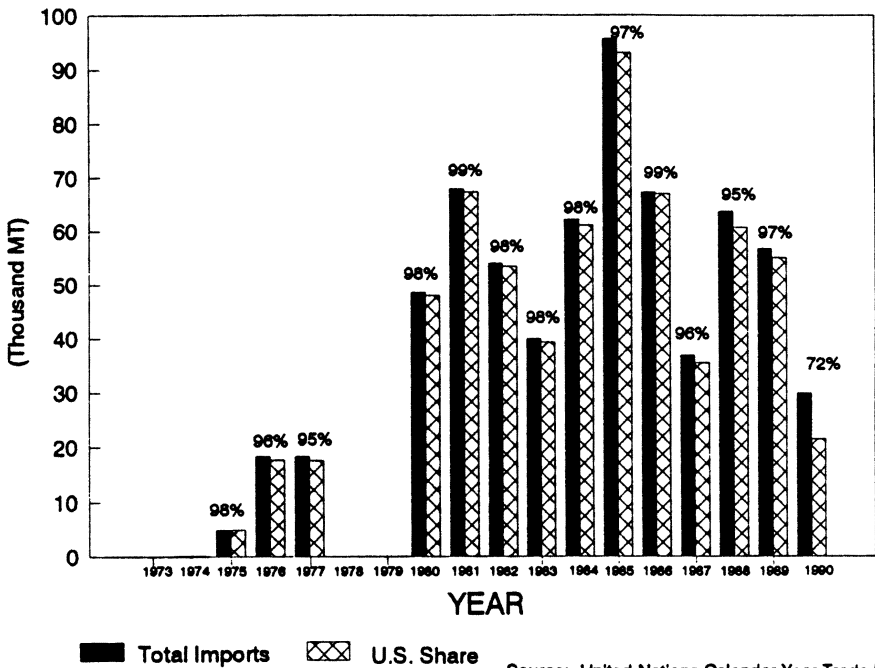
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## An Econometric Import Demand and Market Analysis: The Case of Pork in Mexico

The world population is expected to reach 7.2 billion people by 2010, with developing countries accounting for nearly 90 percent of the population growth. The future demand in consumer food products this will create represents an unprecedented opportunity for U.S. food exporters (Rosson and Ruppel, 1988). Mexico is representative of such developing countries with tremendous foreign market opportunities. With its close proximity and growing economy, Mexico has become one of the fastest growing agricultural export markets of the United States. Agricultural exports to Mexico from the U.S. have grown from \$1.4 billion in the mid 1980s to over \$3 billion in 1991. A substantial amount of this increase in agricultural exports has been from consumer meat products, particularly fresh and frozen pork. Pork imports in Mexico grew from nearly zero in the early 1970s to over 90 thousand metric tons by the mid 1980s. The U.S. has been Mexico's primary supplier of imported pork, on average 96 percent of all Mexican pork imports have been purchased from the U.S. between 1973 and 1990 (Figure 1). Although Mexico is our second largest export market for fresh and frozen pork, changing economic and market conditions have made the quantity imported highly variable.



Source: United Nations Calendar Year Trade Data

Figure 1. U.S. Share of Mexican Pork Imports, 1973-1990.

The objectives of this paper are twofold. The first is to provide an overview of the Mexican economy and pork market. This will aid in understanding the economic and market forces contributing to instability of exports. The second is to determine the underlying relationships influencing the import demand of pork in Mexico. An econometric analysis is performed to aid in understanding future fluctuations in the Mexican pork market, although the same market forces that created the instability in pork imports also plague the empirical analysis.

## **Overview of the Mexican Economy**

The past few decades have brought enormous economic problems to Mexico. Many of these problems resulted from trade policies restricting imports and foreign investment while promoting self sufficiency in agricultural production. Like many other countries, the government sought to implement their plan of economic growth through the industrial sector. The Mexican plan of growth through industrialization was supported by intense investment financed by growing export revenues from oil and foreign loans. When oil prices fell in the 1980s, the government responded by borrowing capital at high interest rates. Foreign debt increased from approximately \$9 billion in 1973 to over \$109 billion in 1987. As a consequence of excessive government spending Mexican consumers experienced rapid inflation reaching over 150 percent by 1987, coupled with a growing deficit reaching 16 percent of gross domestic product (GDP). In addition, several years of drought during the 1980s forced Mexico to import many basic food commodities on a large scale.

Although Mexico's economic dilemma seemed irreversible, the Mexican government has made tremendous progress in overcoming the economic problems that plagued the growth and development of the country. The Mexican government now has moved to a free market economy which encourages foreign trade and investment. Their maximum tariff rate has been reduced to 20 percent from 100 percent. Other non-tariff barriers such as import licenses and health requirements were eased or terminated to promote trade, in accordance with the General Agreement on Tariffs and Trade (GATT) which Mexico joined in 1986 (*Agricultural Outlook*, 1992).

After having the second largest debt of any Latin American country, Mexico is considered very successful among debtor nations in overcoming its debt crisis. In addition, inflation has fallen from 150 percent in 1987 to less than 13 percent in 1992. The result of these reforms has been an increase in economic growth of 3.5 percent in 1991, and based upon current economic conditions, analysts are predicting this rate will continue for at least five more years (*Farmline*, 1992).

Like many developing countries, Mexico has had substantial population growth. The population was 84 million in 1992, approximately one-third the size of the U.S population. According to projections, the population is expected to grow at a rate of 3.3 percent, reaching 95 million by 1995 and 104 million by the year 2000. The median age is estimated at 19 years, approximately ten years younger than the median age in the U.S. The middle class in Mexico is estimated to contain 27 million consumers, or 30 percent of the population, and it is this segment that is considered the most likely to purchase pork and other meats on a regular basis (*Ag Exporter*, 1991).

## **Analysis of Meat Demand in Mexico**

### **Primary Sectors of the Mexican Meat Market**

Consumers in Mexico can purchase meats through many different outlets. A study by the U.S. Meat Export Federation determined the following outlets comprise approximately 50 percent of the potential meat demanded by consumers in Mexico in 1990. These include: self service stores, hotels, restaurants, industrial caterers, and hospitals. The following is a breakdown of the estimated pork demand for each sector in Mexico.

There are approximately 800 self-service stores (supermarkets) in Mexico that are owned by both the government and private enterprises. Self service stores offer a variety of different meats, but pork, beef, and chicken are the primary meats purchased in these markets. It was estimated that approximately 250,000 metric tons of meat were demanded by self service-stores in Mexico in 1990. This represents the largest market sector with 27 percent of the potential meat demand. Of these estimates, 65 percent is beef, 14 percent is pork, and 16 percent is chicken.

There is a growing demand for pork and other meats in the hotel sector. Of the 1,170 hotels, it was estimated (based upon the number of hotels with restaurants and the average consumption of visitors) that roughly 67,000 metric tons of meat were demanded by this industry in 1990 where 20 percent is pork, 37 percent beef, and 33 percent chicken.

A large portion of this demand can be attributed to increased tourism. In 1990, approximately six million foreign tourists visited Mexico. This estimate is expected to increase to approximately ten million by 1994. Tourists typically demand higher-priced cuts, which are primarily supplied through imports. As the number of tourists increases, the quantity of meats demanded by this sector will undoubtedly increase (*Pork*, 1991).

There are approximately 13,000 to 15,000 restaurants in Mexico. Restaurants are estimated to demand nearly 132,000 metric tons of

meat or 14 percent of the estimated demand in 1990. Of this estimate 64 percent is beef, 9 percent pork, and 22 percent chicken.

In the industrial sector, meats are served in industrial and institutional dining rooms. The potential demand estimated for these establishments was from 2000 to 7000 metric tons of meat in 1990, representing less than 1 percent of the market. This segment is comprised of 76 percent beef, 17 percent pork, and 5 percent chicken.

Private and public hospitals are estimated to demand roughly 5000 metric tons of meat each year. This estimate was based upon the number of hospital beds and the average portion of meat served per visitor. Beef and chicken account for nearly 80 percent of the estimated demand in hospitals, while pork is less than 20 percent.

Overall, the breakdown by sectors (Table 1) revealed that beef has the largest estimated potential demand in Mexico with 65 percent of the market, followed by chicken at 21 percent, and pork at 14 percent.

**Table 1. Estimated Demand for Meats in Mexico By Sectors in 1990 (MT)**

	Pork	Beef	Chicken
Self Service Stores	35,000	162,500	40,000
Hotels	13,400	24,790	22,110
Restaurants	11,880	84,480	29,040
Industrial Caterers	765	3,420	225
Hospitals	1,000	2,000	2,000
<b>Total</b>	<b>62,045</b>	<b>277,190</b>	<b>93,375</b>

Source: Analysis and Opportunities of the Mexican Meat Market, U.S. Meat Export Federation, 1990.

In terms of retail prices between 1985 and 1990, beef was the highest priced meat in Mexico, while pork and chicken had a similar range in prices over the five year period (Figure 2). Although retail meat prices have increased, the real minimum salary of Mexican consumers has declined (Figure 3). Since the majority of Mexican consumers are in the low to middle income range, Mexican consumers may have decreased consumption of higher priced animal proteins and increased consumption of cheaper vegetable proteins (Thompson and Hillman, 1989).

### **Pork Consumption and Projected Demand**

Actual per capita consumption of pork in Mexico decreased between 1985 and 1990 (Table 2). Oddly, consumption was higher during 1986 to 1988, which corresponded to years of high inflation and lower minimum salaries. Overall, per capita consumption averaged 11 kilograms annually between 1986 and 1990, approximately one-third that of the U.S. and Canada.

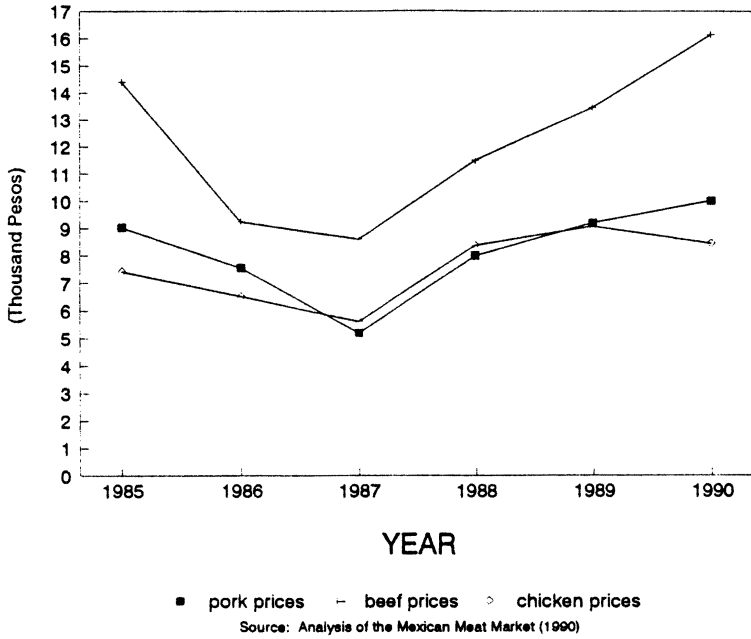


Figure 2. Mexican Consumer Prices of Pork, Beef, and Chicken, 1985-1990.

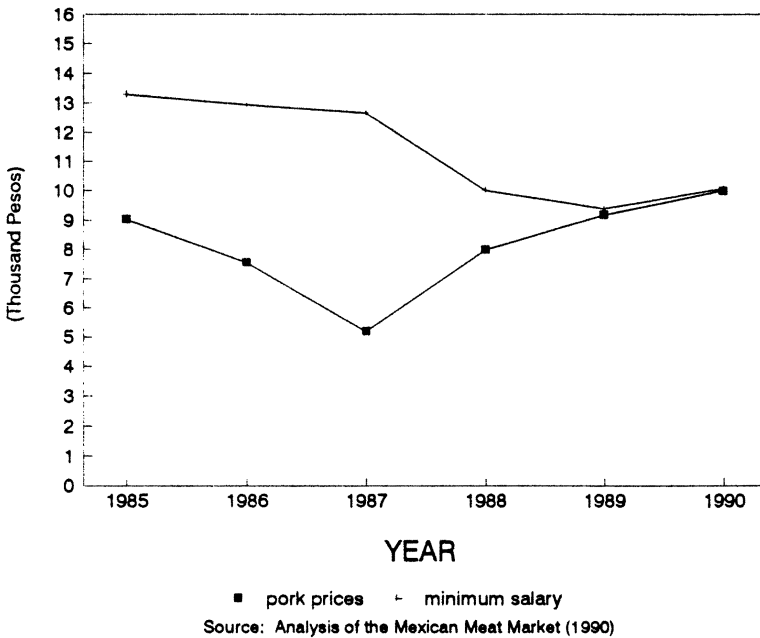


Figure 3. Consumer Pork Prices and Decline in the Minimum Salary.

**Table 2. Per Capita Consumption: Pork (Kilograms)**

	1986	1987	1988	1989	1990	86-90/Avg
Mexico	11.3	11.6	11.7	10.9	9.3	11.0
U.S.	28.4	28.5	30.5	30.2	29.0	29.3
Canada	33.3	33.2	33.9	34.0	33.2	33.5

Source: National Pork Producers Council (1992)

With rapidly improving economic conditions and a growing population, it was estimated (based upon the daily recommended consumption, estimated population, and socioeconomic levels) that between 1990 and 1995 the potential demand for meat in Mexico will increase by 18.4 percent from 927,000 metric tons to 1,097,000 metric tons. Pork accounts for 15 percent of this demand and is projected to increase to 170,000 metric tons by 1995 (*Analysis and Opportunities of the Mexican Meat Market*, 1990).

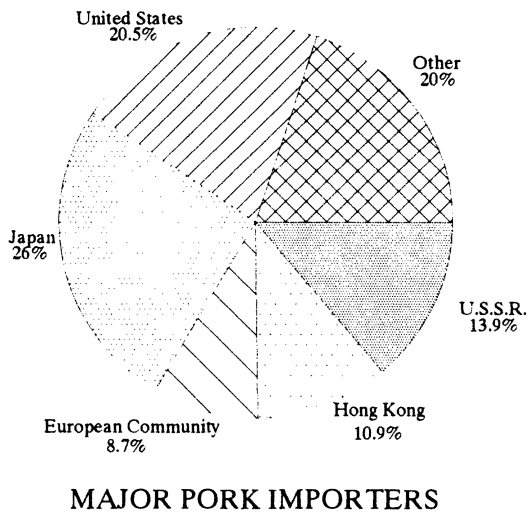
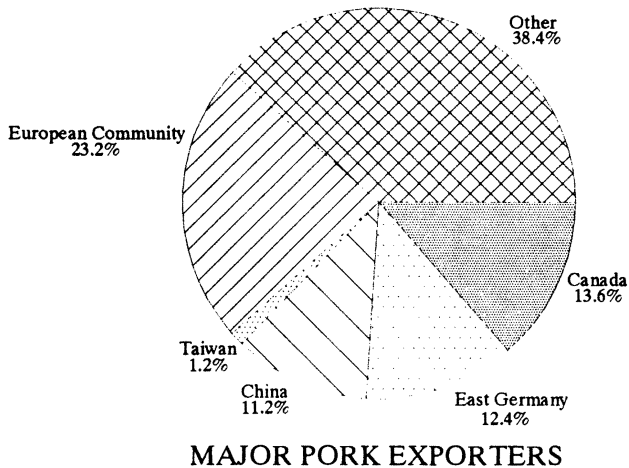
## World Pork Market

On a global scale more pork is produced and consumed than any other meat product excluding fish. In the past 20 years world consumption of pork has increased by over 30 percent. Although consumption of pork is worldwide, production tends to be centralized in only five regions (Figure 4). In 1988, approximately 85 percent of the world's pork was produced in China, the European Community, Eastern Europe, the United States, and the former Soviet Union (Shagam, 1990; Tvedt, 1992).

Trade in pork has been low with less than 6 percent of total production exported to other regions. Approximately 91 percent of all pork exported in 1988 was from Eastern Europe, Canada, China, Eastern Germany, and Taiwan. In 1989 approximately 95 percent of pork imported throughout the world was in the U.S., Japan, the former Soviet Union, Hong Kong, and the European Community (Rawls, 1991). The U.S. is not only one of the largest producers, but also is one of the world's largest importers of pork. A large portion of U.S. imports have been purchased from Canada and Denmark because of lower prices from government subsidies on pork production and exports. If the current round of GATT negotiations is successful in removing these subsidies, the U.S. will likely decrease pork imports from these countries and become a larger player in the more competitive pork export markets.

Pork trade patterns have been significantly affected by diseases, such as hoof and mouth disease and hog cholera. Currently, the U.S. and





Source: FAO Trade Yearbook

Figure 4. Major Pork Exporters and Importers, 1991.

other countries which are free of hoof and mouth disease will not import live swine or unprocessed pork from countries where the disease is present. This has important ramifications since the two largest pork producing regions of China and Eastern Europe, which have hoof and mouth disease, cannot export to the two largest pork import markets of the U.S. and Japan (Shagam, 1990). Similarly, the U.S. prohibits imports of pork and live hogs from Mexico and other countries due to hog cholera.

## **Pork Supply in Mexico**

Mexico's economic problems in the past two decades have directly influenced the pork industry and its development. Production has been unstable ranging from approximately 600 to 1500 metric tons annually between 1973 and 1990. Between 1985 and 1989, production declined as a result of increasing production costs and price ceilings set on pork at the farm level. Several years of drought during the 1980s led to lower feedgrain production and high feed prices for Mexican swine producers. In addition the Mexican government restricted the use of imported feed grains for livestock production. Other major problems confronting the pork industry in Mexico include:

- low technology level of producers in controlling disease;
- high cost of feed grains;
- excessive middlemen in the food chain;
- low number of federally inspected slaughtering facilities;
- lower tariffs increasing competition; and
- little differentiation of prices in the quality of cuts.

The Mexican government has attempted to improve the domestic pork industry by allowing all breeding stock to be imported at a lower tariff rate of 10 percent, while tariffs of 20 percent were set on all live hogs imported for slaughter and on imported pork products. Mexico's hog supply is currently increasing by approximately 3 percent annually. The Mexican government is considering several policies to improve the domestic pork industry such as, increased vertical integration, implementing a carcass grading system, and subsidizing pork producers.

## **North American Free Trade Agreement**

To promote the growing trade alliance between the United States, Mexico, and Canada, President Bush of the United States, President Salinas de Guitari of Mexico, and Prime Minister Mulroney of Canada signed the North American Free Trade Agreement (NAFTA) in August of 1992. NAFTA calls for the gradual elimination of all trade barriers

between Canada, the United States, and Mexico in efforts to promote economic growth of the three countries through international trade. Once signed, NAFTA would create a market of over 365 million consumers of which 88 million are Mexican, 27 million are Canadian, and 250 million are Americans. Currently, NAFTA must be submitted to Congress for approval. If approved, NAFTA could go into effect by January of 1994.

NAFTA is expected to have a larger impact on U.S. pork exports compared to other U.S. meat exports, since historically Mexican tariffs have been higher for imports of U.S. pork products. Under the current pork provisions of NAFTA, Mexico's tariffs of 10 and 20 percent on pork imports from the U.S. and Canada will be phased out over the next ten years, but certain safeguard measures will be established. These measures will be in the form of a tariff rate quota which will allow a predetermined quantity of pork imports in Mexico from the U.S. and Canada to enter at the current NAFTA tariff rate. The size of the allotted quota will increase by three percent per year over the next ten years. Any imports over the allotted quota will be applied to the current tariff rate. On most pork items the tariff rate will decline by 2 percent per year and the tariff rate quotas will become zero following the ten year phasing out period (U.S. Meat Export Federation, 1993).

With the North American Free Trade Agreement (NAFTA) expected to be approved, trade between the U.S. and Mexico will most likely result in increased exports of meat products such as pork. The U.S. Meat Export Federation has estimated that Mexican pork imports could reach 300,000 to 400,000 metric tons by the year 2000. The U.S. will likely remain the primary supplier of imported pork in Mexico, but Canada could capture a significant share of this market. In 1990 the U.S. share of imports fell from 97 to 72 percent as the Canadian share of imports grew to 13 percent of total imports.

In the long run Mexican pork producers should substantially increase production by vertically integrating to reduce production costs. NAFTA will enable more feed grains to be imported, thus allowing pork producers in Mexico to obtain lower cost feed grains which should increase domestic production. Gains in production are not expected to keep pace with the growing demand of the expanding population.

## **Pork Import Demand in Mexico**

Although previous sections discussed a variety of factors which affect the demand for pork, it is important to empirically determine the factors influencing the import demand of pork in Mexico. By assuming perfect substitutability between domestic and imported goods, import demand is identified as the difference between domestic demand and

supply. Economic theory suggests that the demand for imports is dependent upon income, the price of imports, and the prices of other goods. Domestic supply is primarily determined by input and output prices. Thus, import demand for pork in Mexico is a function of the price of imported pork ( $P_{IP}$ ), the prices of other goods ( $P_1$ ), income ( $Y$ ), and domestic supply of pork ( $SP$ ).

$$M_P = M_P(P_{IP}, P_1, \dots, n, Y, S_P) \quad (4.2)$$

It is from this behavioral equation that the following model was derived:

$$NPCIP_t = \beta_0 - \beta_1 RWPP_t + \beta_2 RWPB_t - \beta_3 RWPOT_t + \beta_4 PCGNP_t - \beta_5 PCPROD_t + \beta_6 DI + U_t \quad (4.3)$$

Where

$NPCIP_t$  = Net per-capita imports of pork in Mexico in metric tons calculated by:

$$NPCIP_t = \left( \frac{IMP_t - EXP_t}{POP_t} \right) (1000) \quad (4.4)$$

Where  $IMP$  is the imports of pork in Mexico,  $EXP$  is the exports of pork from Mexico, and  $POP$  is the population in Mexico.

$RWPP_t$  = Real wholesale price of imported pork in Mexico in dollars per metric ton calculated by:

$$RWPP_t = \left( \frac{PIP_t}{IPI_t} \right) (100) \quad (4.5)$$

Where  $PIP$  is the nominal wholesale price of imported pork in U.S. dollars per metric ton deflated by Mexico's import price index ( $IPI$ ) with 1987 as the base year.

The real wholesale price of imported beef in Mexico and the real wholesale price of imported potatoes in Mexico in U.S. dollars per metric ton were calculated in a similar manner.

$PCGNP_t$  = Real per-capita Gross National Product ( $GNP$ ) in Mexico in U.S. dollars.

$$PCGNP_t = \frac{\left( \frac{GNP_t}{POP_t} \right)}{CPI_t} \quad (4.6)$$

Where  $GNP$  is total nominal gross national product of Mexico in U.S. dollars,  $POP$  is the population in Mexico deflated by the U.S. consumer price index ( $CPI$ ).

$PCPROD_t$  = Per-capita production of Pork in Mexico.

$$PCPROD_t = \left( \frac{PRO_t}{POP_t} \right) (1000) \quad (4.7)$$

Where PRO is the production of pork in Mexico in metric tons, and POP is the population in Mexico.

D1 = A dummy variable for imports in years when imports of pork were zero.

t = Year

U = Random disturbance term

The signs of the coefficients are expected to be consistent with economic theory. RWPP is expected to have a negative sign, since its own price and the quantity of pork purchased are inversely related. RWPB is considered a substitute for pork and should have a positive sign, as a rise (fall) in the price of beef is hypothesized to lead to an increase (decrease) in the quantity of pork purchased. RWPO is hypothesized to have a negative sign since pork and potatoes are expected to have a complementary relationship, thus a rise (fall) in the price of potatoes is expected to decrease (increase) the quantity of pork purchased. PCGNP should have a positive sign, as an increase (decrease) in real consumers income should lead to an increase (decrease) in the quantity of pork purchased. PCPROD is presumed to be negative as an increase (decrease) in the domestic production of pork will lead to a decrease (increase) in the quantity of imported pork. The expected sign of D1, the dummy variable, is ambiguous.

Both linear and log-linear functional forms of the equation were estimated using ordinary least squares (OLS). In choosing between functional forms, the work of Boylan, Cuddy, and O'Muirheartaigh (1979), Khan and Ross (1976), Magne and Goodwin (1990), and Salas (1991) [who followed the method of choosing between functional forms introduced by Box and Cox (1964)]. The Box-Cox transformation allows the data to determine which functional form is the most appropriate.<sup>2</sup>

The time period of this estimation is from 1973 to 1990. These beginning years were chosen since, in 1973, the U.S. switched from a fixed to floating currency and 1990 represents the most current data available.

The quantity and price of imported pork was obtained from the United Nations Calendar Year Trade Data. Per-capita GNP, import prices for potatoes and beef, and the domestic production of pork were obtained from the Socio-economic Time Series Access Retrieval System (STARS) database of the World Bank.

The actual values of per-capita imports of pork and per-capita production are multiplied by a thousand to reduce the number of decimal places. In 1978 and 1979, the two years where imports were zero, prices were computed as a weighted average of the previous years. The import prices of beef and potatoes were used as a proxy for domestic prices

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<sup>2</sup> The log-linear functional form is used interchangeably with the term log-log; both imply a logarithmic transformation of the dependent and independent variables.

**Table 3. Estimated Results of Linear Models for Mexican Pork Import Demand, 1973-1990**

MODEL	CONST	RWPP	RWPB	D1	PCGNP	PCPROD	RWPOT	DW	R <sup>2</sup>	ADJ R <sup>2</sup>	DF
1	0.1986 (0.559)	-0.234* (-1.87)	0.2986** (3.081)	-0.476** (-2.42)	-0.158 (-0.894)	21.15' (0.8)	0.514 (0.51)	2.13	0.74	0.50	11
2	0.1904 (0.555)	-0.212* (-1.86)	0.2932** (3.14)	-0.5** (-2.7)	-0.112 (-0.76)	20.61 (0.8)		2.25	0.73	0.62	12
3	0.2495 (0.756)	-0.254** (-2.54)	0.322** (3.79)	-0.473** (-2.63)	-0.246 (-0.25)			2.36	0.72	0.63	13
4	0.1895	-0.254**	0.32**	-0.48**				2.33	0.72	0.65	14

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- Const = Constant
- RWPP = Real wholesale price of imported pork
- RWPB = Real wholesale price of imported beef
- D1 = Dummy variable for years of zero pork imports (1978/79)
- PCGNP = Real Per-capita GNP in Mexico
- PCPROD = Per-capita production of pork in Mexico
- RWPOT = Real wholesale price of imported potatoes
- DW = Durbin Watson Statistic
- DF = Degrees freedom

t-statistics are in parenthesis below the estimated coefficients

\* Significant at 10 percent

\*\* Significant at 5 percent

**Table 4. Estimated Results of Log-Linear Models for Mexican Pork Import Demand, 1973-1990.**

MODEL	CONST	LRWPP	LRWPB	D1	LPCGNP	LPCPROD	LRWPOT	DW	R <sup>2</sup>	ADJ R <sup>2</sup>	DF
1	5.238 (0.156)	-3.07** (-2.26)	1.91** (1.79)	-12.75** (-9.2)	0.946 (0.297)	0.315 (0.114)	-1.05 (-0.73)	1.47	0.91	0.86	11
2	2.015 (0.117)	-3.16** (-2.98)	1.956* (2.04)	-12.73** (-9.72)	1.21 (0.57)		-1.02 (-0.748)	1.49	0.90	0.87	12
3	4.27 (0.256)	-3.36** (-3.33)	2.01* (2.13)	-12.55** (-9.92)	0.349 (0.199)			1.23	0.90	0.87	13
4	6.91 (0.702)	-3.34** (-3.45)	1.998* (2.20)	-12.51** (-10.40)				1.23	0.90	0.88	14

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- Const = Constant
- LRWPP = Log of wholesale price of imported pork
- LRWPB = Log of wholesale price of imported beef
- D1 = Dummy variable for years of zero pork imports (1978/79)
- LPCGNP = Log of Per-capita GNP
- LPCPROD = Log of Per-capita production
- LRWPOT = Log of wholesale price of imported potatoes
- DW = Durbin Watson Statistic
- DF = Degrees freedom

t-statistics are in parenthesis below the estimated coefficients

\* Significant at 10 percent

\*\* Significant at 5 percent

because of data limitations on domestic prices in Mexico. These were used under the assumption that imported beef and potatoes are perfect substitutes for those produced domestically.

## Linear Model Results

Model 1 (Table 3) represents the original unrestricted model in linear form. The estimated coefficient RWPP had the expected (negative) sign and was significant at the 10 percent level as indicated by the t-statistic below the coefficient. The estimated coefficient RWPB also had the expected (positive) sign, indicating that pork and beef are substitutes, and was significant at the 5 percent level. The dummy variable was also significant at the 5 percent level. The price of imported potatoes (RWPOT), per-capita production (PCPROD), and per-capita GNP (PCGNP) all had signs inconsistent with economic theory, but each variable was insignificant at the 10 percent level. Thus, every statistically significant variable had the expected sign.

The  $R^2$  combined with the insignificance of the coefficients suggested that multicollinearity could be a problem in the model. The Klein test was used to detect for multicollinearity where each regressor is regressed on the remaining variables to obtain an  $R^2_i$ , where  $i$  refers to the dependent variable of each auxiliary regression. In each run, the  $R^2_i$  was lower than the  $R^2$  of the original model (.74) indicating multicollinearity was probably not a serious problem in the data.

In each run of the linear models, the estimated coefficients for the real wholesale price of imported potatoes (RWPOT), per-capita production (PCPROD), and per-capita GNP (PCGNP) were insignificant at the 10 percent level. These results indicate the net per-capita import demand for pork in Mexico is dependent upon the real wholesale price of imported pork (RWPP), and the real wholesale price of imported beef (RWPB).

## Log-linear Results

The empirical estimates of the model in log-linear functional form are listed in Table 4. In the original run of the model, the Durbin Watson of 1.46 was inconclusive in detecting first-order autocorrelation. After correcting for first order autocorrelation with the Cochrane-Orcutt iterative method the estimated coefficients became insignificant, therefore, the original estimates were retained. All of the variables except LPCPROD had signs consistent with economic theory. As indicated by the t-statistics in parenthesis, only the parameter estimates for LRWPP and D1 were significant at the 5 percent level. The estimated coefficients for LRWPOT, LPCPROD, and LPCGNP were all insignificant.



In the log-linear functional form, the estimated coefficients correspond to the elasticities. The coefficient for the real wholesale price of imported pork (LRWPP) implied that a 1 percent increase in the price of imported pork (*ceteris paribus*) would lead to a decrease of 3.07 percent in the quantity of pork imported. The positive sign of the LRWPB coefficient indicated that beef and pork are substitutes, and indicated that a 1 percent increase in the price of imported beef (*ceteris parabis*) would lead to a 1.91 percent increase in the quantity of pork imported. The size of the estimated coefficients indicated that the demand for pork is elastic with respect to its own price and the price of imported beef. The positive sign of the estimated coefficient for LPCGNP indicated that imported pork is a normal good, and a 1 percent increase in per-capita GNP (*ceteris parabis*) would generate a .94 percent increase in the quantity of pork imported. The estimated coefficient for the wholesale price of imported potatoes (LRWPOT), indicated that pork and potatoes are complements, thus a 1 percent increase in the price of potatoes would lead to a 1.02 percent decrease in the quantity of pork imported (*ceteris parabis*).

Overall there was little variation in the estimates between the four log-linear models. The empirical results indicated that the net per-capita import demand for pork in Mexico is dependent upon the real wholesale price of imported pork, and the real wholesale price of imported beef. The size of the estimated elasticities implied that net per-capita import demand is most responsive to a change in the real wholesale price of imported pork succeeded by the real wholesale price of imported beef.

In both the linear and log-linear runs, it could not be rejected that the estimated coefficients for per-capita GNP, per-capita production, and the price of potatoes were statistically different from zero based upon t-statistics at the 10 percent level. The insignificance of the coefficients would tend to support model 4 as the preferred specification, where net per-capita pork imports are dependent upon the price of imported pork (RWPP), the price of imported beef (RWPB), and the dummy variable (D1). Since economic theory implies demand is dependent upon both prices and income, model 3 is preferred because it includes per-capita GNP (PCGNP) as a measure of income.

A likelihood ratio test was performed using a Box-Cox transformation of the data to determine whether the two functional forms are statistically equal. The result of the maximum likelihood estimation was a likelihood ratio (LR) value of 33.99 thus, at the 5 percent level of significance, the null hypothesis that the two functional forms are statistically the same was rejected. Based upon the signs, size, and statistical significance of the coefficients, the log-linear estimates are considered superior to the linear estimates, which supports the work of Khan and Ross (1977), and Boylan, Cuddy, and O'Muircheartaigh (1979).

The significance of the dummy variable for years when no imports of pork were reported was reason to suspect possible intervention by the Mexican government. It was expected there was a policy resulting in zero pork imports, but no policy was documented in the sources reviewed by the authors. It was discovered that in 1978 and 1979, the two years when imports were zero, Mexico had started moving to more liberal trade policies by lowering tariffs and reducing non-tariff barriers of various commodities. This was in accordance with the membership requirements of the General Agreement on Tariffs and Trade (GATT). Also, Mexico's increases in oil exports brought much needed foreign exchange into the country. The increases in foreign exchange along with the liberalizing of trade policies led to increases in total imports by 38 percent and 57 percent in 1978 and 1979 (Salas, 1981).

## **Summary**

In this study a perfect substitutes per-capita import demand model was estimated using data from 1973 to 1990. Both linear and log-linear forms of the import demand equation were estimated using ordinary least squares (OLS). The empirical results indicated the import demand for pork in Mexico is determined by the price of imported pork (own price) and the price of imported beef (price of substitute). It was also determined that the demand for imported pork in Mexico is elastic with respect to its own price and the price of imported beef. The likelihood ratio test revealed that the two functional forms were not statistically the same. Based upon the signs, size, and statistical significance of the parameter estimates, the log-linear functional form was preferred over the linear functional form.

### **Limitations of this Study**

Certain limitations of this study should be considered before interpreting the results. Domestic price data for the wholesale prices of beef and potatoes was unavailable for the complete time period. The assumption that import prices are proxies for domestic prices could lead to erroneous results if import prices and domestic prices differed sizably. Also, including the dummy variable may be incorrect if the data was accurate and there was no policy limiting imports. If zero imports actually occurred during 1978 and 1979, and not as a result of any restriction, including this variable could lead to incorrect estimates. The use of weighted average prices for years when imports were zero has also confined the own price estimates by not allowing prices to fluctuate with the market.

Since Mexico is becoming a large importer of pork and other meats any significant changes in supply and demand in Mexico are likely to affect world prices. Further research on this commodity and market will

allow U.S. producers, processors, and policy makers to better respond to changes in the Mexican pork market.

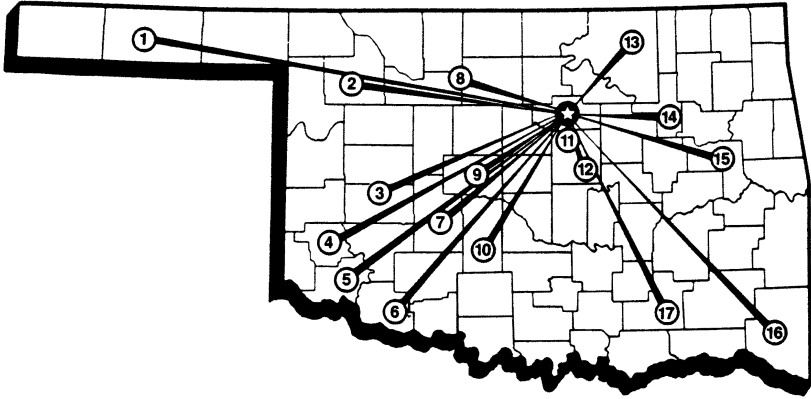
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